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ROENTGEN THERAPY OF GLIOMAS OF THE BRAIN*

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INTRODUCTION

IN spite of the remarkable strides which cranial surgery has taken in the last twenty years, there are still many intracranial tumors which cannot be completely removed by surgical means. Especially is this true of the gliomas, so that some other therapeutic agent is needed for their treatment. The roentgen rays have been used for this purpose with good results; in fact, they have produced such marked improvement in certain gliomas as to lead to an over-estimation of their effect upon these growths.

The belief in roentgen therapy has even led certain authors to advocate its trial, before resorting to surgical intervention, in every case suspected of being an intracranial neoplasm. Béclère[1] wrote that in such cases the physician should always try roentgen therapy before surgical intervention because such treatment is without the inconveniences and dangers of surgery. As a matter of principle, he said, it is only after a proper trial of roentgen therapy that one should subject the patient to an operation.

But there is not lacking either in the literature or in our own experience sufficient evidence to prove that roentgen therapy carries with it, in such cases, both inconvenience and danger. Thus in the series of Roussy, Laborde and Lévy,[2] in Case I, treatment was followed by violent headache and coma; in Case II, by increase of headache and vomiting; in Case III, by coma; in Case IV, by coma and death. Similarly in the series of Flatau,[3] in Case IV treatment was followed by coma and death. De Beule[4] has reported a death with signs of meningeal irritation following deep radiotherapy. We might call attention also, in this connection, to similar accidents which occurred in Cases 4 and 18 of this report, in which single treatments of 1000 electrostatic-unit-seconds resulted in coma in the case of a glioma of the right cerebral hemisphere and of a glioma of the cerebellum. Tumors of the spinal cord may react in the same way. Schaeffer and Jacob[5] recorded an instance of rapid aggravation of symptoms and death in a woman with an easily removable tumor of the spinal canal, following roentgen therapy.

These accidents are so common that Tassitch[6] was able to write that in searching for all the observations of cerebral tumor treated by radiotherapy which were known to him the mortality was 16.9 per cent (somewhat higher than the average mortality for surgical treatment in this clinic). Tassitch added 2 cases of his own. In his obs. IX, the patient became comatose and died following roentgen-ray treatment;

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in obs. x the same result was obtained, and he remarked (p. 51) that "generally in all observations on cerebral tumor treatment by deep radiotherapy we find the same picture after the first treatment; headache redoubled in intensity, vomiting more frequent, visual troubles more pronounced, psychic troubles appear." This increase of symptoms after treatment is common in our own experience also.

These unfortunate results of roentgen therapy led Roussy, Laborde and Lévy[2] to protest against the indiscriminate use of roentgen therapy of brain tumors. They concluded that at the present time roentgen (or radium) therapy cannot compare with surgical treatment in these cases. In their opinion surgery should remove a tumor when possible as soon as it can be localized; surgery also should combat the intracranial hypertension, and only afterwards should it be permissible to proceed with roentgen therapy. One of us[7] in the course of some recent remarks on the roentgen therapy of brain tumors arrived at very similar conclusions. This opinion is now generally held (Olivecrona; Bremer,[7a] Coppez and Sluys; Laruelle).

In fact, to proceed otherwise places one liable to many errors.

1. *One is not certain to be dealing with a brain tumor.* A good example is the series of Nordentoft,[5] so often quoted. In only one of his 19 cases was the presence of an intracranial neoplasm verified, and this by an operation which cured the patient after roentgen therapy had failed. At the time of his first report Christiansen[9] (and his associate Neel) pointed out that many of the cases were obviously from the clinical histories not intracranial neoplasms, and a perusal of Nordentoft's reports must lead one to agree with Christiansen.

2. *One may mistake the localization of the lesion.* A good example is Flatau's[3] Case 1, which was treated in the *right* frontal region, and at necropsy there was found an easily removable meningioma in the *left* frontal region. Another example is the Case 1 of Roussy, Laborde and Lévy[2] where a patient was treated with intense doses in the *parietal* region. At necropsy, in the *cerebellum* was found a huge cyst—a lesion with an excellent operative prognosis. Such errors will happen to anyone who tries to treat brain tumors with the roentgen ray before the localization of the lesion is verified.

3. *One may lose time by treating a lesion with a good operative prognosis but very resistant to the roentgen rays.* It is always desirable in the practice of medicine to make a two-fold diagnosis—of the location of the lesion and of its nature. Both diagnoses may be difficult in the case of intracranial tumors, but the latter is more difficult. Still it is possible to make a positive diagnosis of meningioma in a large percentage of cases (in 50 per cent of the cases by means of the roentgen ray alone, as one of us[10] has pointed out). It is possible to make a positive diagnosis of tumors arising from Rathke's pouch[11] in an even greater percentage of cases (in 75 per cent by the roentgen ray alone). A positive diagnosis of acoustic neurinoma may also be made from the clinical examination alone in over 90 per cent of the cases. These are all favorable tumors for surgical intervention, and the earlier they are attacked, the better are the results. On the other hand, in our experience they do not improve under roentgen therapy, and we know of no verified tumor of either of these three types which was improved by roentgen treatment.

When a pre-operative pathological diagnosis cannot be made, there is still considerable chance that the lesion is of these types. Even should the tumor prove to be a glioma, it must be remembered that one-fourth of such tumors are cystic and excellent operative risks,[12] while another one-fourth are of slowly growing types with an excellent postoperative prognosis.

4. *One may aggravate the symptoms and even cause the death of the patient by roentgen treatment.* We have remarked that even treatment of pituitary adenomas, seemingly the most favorable of intracranial tumors for such therapy, may be followed by grave consequences.

The principal cause of these accidents has been considered to be the "prereaction." Béclerè[13] has recently developed this explanation in detail. The tumor being incarcerated in an inelastic cranium, the

edema and swelling of the "prereaction" causes the immediate increase in symptoms in the majority of cases.

Occasionally, a sudden increase of symptoms is undoubtedly due to hemorrhage into the tumor. It is rare to find normal blood vessels in a cerebral glioma. They almost invariably show various degenerative changes, especially in the type known as spongioblastoma multiforme. These pathological vessels are very unfavorably influenced by radiation. Such accidents as those recorded in Case 27 and others of this report are doubtless due to this cause.

To explain the late deaths following irradiation of brain tumor Tassitch invokes the secretion of hypertoxic products derived from disintegration of the tumor. This may be the cause of death in Case 43 of our report.

In view of the foregoing considerations we are unanimously of the opinion that operation should precede roentgen treatment—an attempt to extirpate the tumor when localizable; a decompression when it is unlocalizable—at least with our present technique. A possible exception to this rule may be made in the case of pituitary adenomas when the visual fields can be carefully followed and operation immediately performed if necessary.

Though some gliomas react favorably to roentgen therapy, the unfavorable reaction of others, and the impossibility of determining beforehand which will react favorably lead us to follow this rule in all cases where this diagnosis is probable.

Even when roentgen therapy is given after proper surgical treatment, it is a familiar fact that two gliomas in the same location will react very differently. It was to determine, if possible, the reason for this variability that the present study was begun in the autumn of 1924. Its publication was delayed from various causes, which has enabled us to collect a more considerable number of cases. In a general way the results bear out the prediction Ewing[14] made in 1921, that those gliomas composed of the more embryological cells would react most favorably to roentgen treatment.

We shall use the records of 62 gliomas in which the nature of the lesion was verified by microscopic examination, so that we know in each case not only that we were dealing with a glioma, but the histological type as well. Such material could only be obtained in a clinic where a considerable number of intracranial neoplasms were treated and we are grateful to Dr. Harvey Cushing for permission to study these records.

Even the material we have collected we feel to be unsatisfactory. The course of an intracranial neoplasm depends not only on its histological structure, but also on its location in the intracranial cavity. To arrive at a truly scientific opinion, it would be necessary to have for each histological type, in a given location, three series—one untreated, another treated by operation and a third treated by roentgen radiation. Since this ideal will never be reached, we feel justified in detailing our experiences to see whether any conclusions can be reasonably drawn from them.

It should be added that, since almost all of our cases were treated after operative interference we have tried to attribute to such intervention its just proportion of the improvement of the patient's condition.

We cannot take space to discuss the histological structure of the various types of gliomas. The reader is referred for this information to the monograph of Bailey and Cushing.[15] Since it is necessary to have some idea, however, whether the length of life of our patients has been prolonged by roentgen treatment, a brief account of the clinical behavior of the different types is given. The following table of the average length of evolution of the various gliomas will also be useful.

AVERAGE SURVIVAL PERIOD IN MONTHS

1. Medulloblastoma		15
2. Neurocepithelioma		..
3. Spongioblastoma multiforme		12
4. Pinealoma		18
5. Ependymoma		25+
6. Astroblastoma		28+
7. Spongioblastoma unipolare		46+
8. Oligodendroglioma		66+
9. Ganglioneuroma		..
10. Astrocytoma	protoplasmaticum	67+
	fibrillare	86+

TECHNIQUE OF IRRADIATION

Selection of Cases. During the past eight years, 456 patients with brain tumors

have been treated by roentgen rays in our department. Of these 222 have been classified as "gliomas," but it has been found necessary to limit the considerations in this paper to 62 cases for the following reasons:

(*a*) Only those cases having sufficient material available for accurate histological classification have been considered. As this tissue was removed at operation in nearly all of the cases, this precaution gives us knowledge of the exact location of the tumor and also data concerning its size and vascularity.

(*b*) Only cases of at least one year's duration since beginning treatment are used with one exception, Case 8, in the group of rapidly growing tumors. In many cases the end-result is known, often with autopsy findings.

(*c*) Only cases having had four or more treatments at three-week intervals are considered with 3 exceptions to be noted, most of the treatments having been given in our own department, with subsequent therapy elsewhere. Unless we could obtain fairly accurate and satisfactory data concerning those treatments, the cases were discarded.

This selection of cases has been made with great care in order to make our results as accurate as possible, and while limiting our numbers to almost one-fourth of those available for study it gives us the most reliable information obtainable. Suffice it to say that the records of the other gliomas have been studied—those verified but receiving insufficient treatment, or unknown treatment elsewhere; those verified by collection of yellow, clotting fluid but without histological classification; those suspected but unlocalized, and treated after decompression only, and those treated without any operation—of which latter group there are but few in the large series. None of these cases have given any more favorable results, nor have they shown worse reactions than some included in this series, and their consideration would not change the conclusions drawn, but would only affect their accuracy.

Technique. All treatments *given in our department* have been delivered by an interrupterless 12-inch transformer, mechanical rectification, using 130 to 140 kv. peak (9 to 10 inch spark gap between blunt points). The *filter* employed most often was 0.25 mm. of rolled copper with one thickness of sole leather on the side next to the patient. Occasionally 5.0 mm. of aluminum has been used in place of the copper. The *distance* was generally 12 inches (30 cm.) from the center of the target to the skin surface, occasionally 10 inches (25 cm.) when a shorter duration was expedient, or 16 inches (40 cm.) when a more uniform depth dose was required. The *portals* of entry were delimited by leaded rubber on the patient's head and further by various lead diaphragms $\frac{1}{4}$ inch thick placed beneath the tube—a broad focus Coolidge tube, Universal model. The portals varied in size to suit the individual case, usually measuring between 8 and 15 cm. in diameter. The *milliamperage* was 6 and the usual time 25 minutes for a full dose which would produce epilation in practically all cases but only occasionally a faint erythema appearing in ten to fourteen days. Such a dose could be repeated at intervals of three weeks, usually with a return of hair several months after the treatments were stopped, and with never more than a slight tanning at any time. Using a Duane ionization chamber the above factors gave an *average effective wave length* of 0.21 Ångström units as determined by the half-absorption method in copper, and an average *intensity* at 12 inches of 0.54 to 0.66 electrostatic units. This gave a single full dose of 800 to 1000 electrostatic-unit-seconds,* *which includes the secondary radiation as measured on the skin surface.* The depth dose in a water phantom with these factors was found to be 17 to 21 per cent at a distance of 10 cm. below the surface, depending on the size of the portals.

The general plan of therapy was to use a single portal, single seance method in the postoperative cases with a trial dose of 60–80 per cent the first day, repeating with 100 per cent doses once every three weeks if no serious reaction ensued. Most cases received four to eight such treatments

* The electrostatic-unit-second is approximately equal to the German R unit and is the same quantity as that recommended for the International Unit of radiotherapy. The French R (Solomon) is 2.7 (Duane) times as much, so that our full dose would be 800 to 1000 R (German) or 2160 to 2700 R (French).

with a repetition of four more after an interva of three to six months. The single area treated in each case was directly over the tumor and usually through the operative field; occasionally in deep or midline tumors, bilateral portals were used with 100 per cent of the above dose on each side on two succeeding days. The portals used were always larger than the tumor found or suspected, in order to reach it all and in order to obtain more secondary radiation. Variations from the above schedule are noted in the individual cases and include most forms of radiation therapy, as practised at present. Radium was used in only 5 cases as noted. To save space in the following reports of cases, the above technique will be denoted "technique A." This means, in short, 132 kv., 30 cm. target-skin distance, 0.25 mm. copper filter, 150 ma-min., through a portal 12 × 12 cm. in size, directly over the tumor. Variations from this are noted.

It is acknowledged that such therapy as above indicated is rather inefficient if one seeks to destroy malignant tissue 5 to 10 cm. below the body surface, but actual destruction in the case of brain tumors is rarely to be sought, for fear of a fatal ending. A more continuous irradiation with an increased depth dose might yield better results, or multiple portals of entry all directed at the same tumor might be tried to secure the same result, but the results of the "massive" doses first advocated with the advent of deep therapy machines certainly preclude any such radiation in this dangerous area. Our present plan which is already in operation is to follow the general scheme first advocated by Kingerey,[16] and more recently by Pfahler[17] which is a "saturation method" and in which we can employ radiation up to 200 kv. in strength with a corresponding increase in depth dose and a more continuous effect on the tumor. This is in accord with the present tendency, especially in France, and follows the general scheme advocated by Béclère. It has the additional advantage of allowing observation of several days between the fractional irradiations, during which the reactions may be noted and serious reactions avoided. It cannot be too strongly emphasized that serious, even fatal, reactions can and do occur following single doses of radiation, and great care must be taken to avoid them, as Béclère indicates. Our comparative freedom from serious reactions has probably been due to the fact that nearly every case has had a decompressive opening made in the skull, and to the fact that only a single portal is used each day with a comparatively low depth dose in the tumor. There have been no fatalities in our series attributable to roentgen-ray therapy, with the possible exception of Case 43.

Various authors have reported their own methods of radiotherapy, some of them of the saturation method, some with multiple portals of entry, some heavily filtered with high penetration, others of low gap and light filters, but the cases are too few or too indefinite to permit of accurate comparison with our cases. Brief mention might be made of the various techniques, however, as follows:

Bremer, Coppez and Sluys[18] use a Gaiffe-Galot-Pilon outfit with the tube in oil, 180,000–200,000 volts, 4 to 6 portals, 40 cm. distance, 0.5 mm. copper filter, giving 3500 to 4000 R (Solomon) to each portal. They gave 1000 R each day, for twelve to fifteen days, occasionally up to twenty days and treated "almost always" after a decompression had been done.

Cluzet (quoted by Tassitch[6]) used 4 portals, 2 lateral, one anterior and one posterior, each area as large as possible without overlapping. He used moderately penetrating rays, 25 cm. spark, 2 ma., 10 mm. aluminum filter, 25 cm. distance; or deep radiotherapy, 40 cm. spark, 3 ma., with 1.0 mm. Cu and 1.0 mm. Al filter. To each portal he gave 20 H, spread over ten to fifteen days, 4 to 5 sessions on each portal. This was repeated after three to four weeks, if necessary.

Japiot (quoted by Tassitch, loc. cit.) used a 40 cm. spark with the tube in oil; filter 4 cm. of oil, 1.0 mm. Cu, 1 mm. Al and 1.0 cm. of paper; distance 27–30 cm.; several portals, either 2 lateral, or one anterior and one posterior or all four were used. Each portal large so that the entire skull was irradiated. At each session, using 3 to 3.5 ma., he gave 5 H or 1000 R, each

portal receiving 20 H or 4000 R. The usual total was 40 H or 8000 R measured at the skin, and spread over twelve to fifteen days.

For medium therapy he used a 20 cm. spark, 2 ma., Coolidge tube in air, 10 mm. Al filter, dose same, portals same, time much longer in consequence. His principle was to irradiate all of the brain with a dose practically homogeneous in all its parts, in order to reach as surely as possible the tumor.

Coste (quoted by Tassitch) never treats gliomas without a decompression. He utilizes 4 to 5 portals, the rays converging upon the lesion; gives his treatments in a single sitting, moderately penetrating rays (16 cm. E.E.) with no filter or only 0.5 mm. Al. His maximum dose is 2500 R. This is repeated several months later if necessary.

Roussy, Laborde and Lévy[2] use a Gaiffe No. 3 machine, 200 kv. (40 cm. spark), 30 cm. distance, portals 10 × 10 cm., filter 0.5 mm. Zn + 2 mm. Al, twice 1 mm. Zn, and more recently 1.0 mm. or 2.0 mm. Cu. Their dosage was 4000 to 4500 R (Solomon) per portal or a total of 12,000 to 20,000 R for each series. Treatments daily, 2600 to 3000 R each portal. These had to be interrupted in several cases because of severe reactions. One patient received 20,000 R from the 10th to 31st of October (20 treatments, 5 portals), and died a month later.

Nordentoft[8] used "5 great fields (forehead, back of neck, crown of head, both temporal regions) with symmetry inductor, through 10 mm. Al, distance 24 cm., 1 skin unit dose . . . Total epilation."

Pancoast[19] has used deep roentgen therapy since 1923, 100 per cent skin dose at the site of the tumor. He had previously used radium.[20]

Post-radiation Changes in Histological Structure. These gliomas vary so much in histological structure, and the degenerative changes which occur spontaneously are so frequent that it has been practically impossible to recognize any constant alteration in the microscopical structure of any type of glioma which we were sure was due to roentgen treatments.

Discussion. As will be evident from a perusal of the following cases, a variety of techniques of irradiation has been employed. Further changes are probable. It is unfair to criticize the earlier methods because they were the custom at the time, and it is unfair to estimate results when we know now that insufficient treatment was being given. It is probable that a similar series using the newer methods of radiotherapy will show better results, chiefly due to the accuracy now obtainable in measuring dosage—but statistics in all branches of radiotherapy are five years behind the times. We hope at least to do less harm and, if possible, to do more good with the machines, equipment and knowledge now at our command.*

A. MEDULLOBLASTOMAS

The medulloblastomas are rapidly growing cellular tumors which occur most often in the central part of the cerebellum of children, but occasionally are found in the cerebral hemispheres. They occur rarely in adults. Bailey and Cushing[21] found the average length of evolution of these cases to be fifteen months. However, this average included some that had been treated with roentgen rays, which we shall see are very effective in retarding their growth. If we exclude the cases treated in this way, the average would be about twelve months, six months before operation is necessary and six to nine months after operation before recurrence necessitates a secondary operation or causes the death of the patient. These tumors vary somewhat in the details of their microscopical structure but have fairly consistently this rapid evolution.

It should be remembered also that it is this type of glioma which most often invades the subarachnoid space and grows there to form what is often called "sarcomatosis of the meninges." After operative removal of cerebellar medulloblastomas, implants in the spinal region are not infrequent.

CASE 1. Surg. No. 11463. *Medulloblastoma of left occipito-parietal region. Decompression. Partial extirpation. Roentgen therapy, T.* 883.

* Many of the early roentgen-ray treatments in this series were given in this hospital by Dr. Lawrence Reynolds, now of Detroit, Mich., and during reconstruction of our department this present year (1927) routine treatments were given at the Collis P. Huntington Memorial Hospital. We wish to express our appreciation of their work in making this study possible.

Secondary extirpation five years later. Death in four months. Necropsy.

K. S. D., aged thirty-one, was admitted Nov. 9, 1919, complaining of nervousness, depression and headache, having been referred by Dr. S. G. Dabney of Louisville, Ky. He had been troubled for the past ten years with poor vision and was obliged to give up his college work on this account. On May 18, 1917, Dr. Dabney found a moderate degree of hypermetropia and hypermetropic astigmatism, but the fundi were normal. Sometimes he would be very much depressed because of his poor eyesight, but worked steadily in the insurance business until 1918, when he had headaches for a few weeks following an attack of influenza. These headaches recurred in July, 1919, and became very severe, accompanied by vomiting. On Oct. 28, 1919, he consulted Dr. Dabney who found bilateral choked discs and referred him to this clinic.

On admission there was found bilateral choked discs of 3 1/2–4 D., a right homonymous hemianopsia and a slight right facial weakness. There were also mild aphasic symptoms consisting mainly of an anomia and alexia.

On Nov. 13, 1919, Dr. Cushing did a left subtemporal decompression. The brain was under considerable tension. Puncture of the hemisphere revealed no lesion. On Nov. 25, Dr. Cushing turned down a bone flap over the left parietal region disclosing in the posterior portion of the field what was evidently the surface extension of a glioma. The anterior margin of the tumor was dissected out and a great mass of the tumor removed with the blunt end of a spoon spatula. The hemorrhage was checked and the wound carefully closed. He recovered promptly and was discharged on Dec. 11. The choked discs had subsided; his aphasic symptoms were about as on admission. He was given roentgen-ray treatment by Dr. Bayless of Louisville, Ky., in December, 1919, 500 ma-min.; January, 1920, 500 ma-min.; May, 1920, 450 ma-min.; September, 1920, 600 ma-min., with 135 kv. at 14 in. focal skin distance filtered through 0.5 mm. copper. In June, 1920, he wrote that he was feeling generally quite well except that he still had an anomia. On Oct. 25, 1921, examination showed that the anomia still persisted. His optic discs were flat. He was quite well except for nervousness and some insomnia.

In April, 1922, he began again to have headaches and when he was examined on April 17 his anomia was more pronounced. He had a right homonymous hemianopsia; optic discs were still flat, and he was feeling in general fairly well. He was given a series of roentgen-ray treatments, January, 1923, 525 ma-min.; May, 1923, 375 ma-min.; December, 1923, 400 ma-min.; and April, 1924, 375 ma-min., by Dr. Bayless, without any apparent influence on his condition, which steadily progressed. In August, 1924, his eyesight began to fail and the decompressed area on the left side had become tense and bulging. His speech difficulty had increased and he was suffering from severe headaches.

He was re-admitted to the hospital on Sept. 13, 1924, Surg. No. 22172. At that time there was a bilateral choked disc of 1 1/2 D.; the decompression was tense and bulging; he had a right homonymous hemianopsia and marked aphasia; also a right hemihypesthesia.

On Sept. 19, 1924, Dr. Cushing reflected the old bone flap and again removed by means of a blunt spatula a large mass of tumor. The patient recovered promptly and was discharged on Oct. 8, 1924. At that time the decompressed area was soft and flat; optic discs had subsided, but the aphasic symptoms had not improved. He was very much depressed and complained of headaches, although he was up and walking around the hospital. He was given one roentgen-ray treatment on Oct. 3, 1924, before his discharge; technique "A." On Dec. 4 his father wrote that his condition had not improved. He had no headaches but still vomited occasionally on arising in the morning. In January, 1925, he began to have severe headache; rapidly became worse, and died on the 31st of January. Necropsy, confined to the head, was done by Dr. Stuart Graves, and the brain sent to the clinic in 10 per cent formalin. There was a large tumor in the left parieto-occipital region.

Impression. The long interval between operation and recurrence, considering the nature of the tumor, was in all probability a direct result of the roentgen therapy. The failure to respond to the second and subsequent treatments is frequently seen and is not necessarily due to an acquired immunity of the tumor cells, for he had already begun to suffer from headaches before the second series was instituted so that there may have been blockage of cerebrospinal fluid which might not only *not* be relieved by the treatments but might even be aggravated.

CASE 2. Surg. No. 11606. *Medulloblastoma of cerebellum. Suboccipital decompression. Roentgen therapy; radium therapy. Death fifteen months after operation. No necropsy.*

H. M., aged six, was admitted to the hospital Dec. 6, 1919, complaining of headache, double vision, vomiting and staggering gait, having

been referred by Dr. Max Goltman of Memphis, Tenn. He had been well until March, 1919, when his mother noticed that he held his head tilted to the right side. In June, 1919, he complained of double vision. Since October he had been unsteady on his feet. On Nov. 15 a lumbar puncture was done and since then he had had severe headaches and vomiting.

On admission to the hospital it was found that he had bilateral choked discs of 2–3 D., a paresis of the right external rectus muscle, a right facial weakness, incoördination of cerebellar type affecting all the extremities, and staggering gait. The head was held tilted to the right. There was rigidity and tenderness of the neck.

On Dec. 8, 1919, Dr. Cushing did a suboccipital exploration disclosing a grayish tumor mass which extended down into the spinal canal. The arch of the atlas had to be removed in order to reach the lower extremity of the tumor. It lay directly within the 4th ventricle, the lower limit of attachment being the calamus scriptorius. The lower end was turned upward and removed for microscopic study, but was so very vascular that no further attempt at extirpation was made. The child recovered and was discharged on Dec. 30, 1919. At that time his headaches and vomiting had ceased; optic discs were still elevated 2–3 D., and his other neurological findings were as on admission.

On Feb. 10, 1920, his father wrote that he had improved a great deal and was up and walking around his home. Shortly afterward roentgen-ray treatments were started by Dr. Chas. Gottlieb of New York City. He was given four treatments, each one skin unit dose, which on his apparatus was 4 ma., 220,000 volts, 0.75 mm. Cu, and 50 cm. distance for 85 min.

He was examined on May 17, 1920. The optic discs were flat; he walked with slight deviation to the right. There was some suboccipital fullness but he was feeling well, with no headaches and only an occasional attack of vomiting. There was some difficulty in swallowing, and the right abducens palsy persisted. The roentgen-ray treatments were interrupted. On June 5, 1920, he began to complain of headache and vomiting which occurred practically every other day. He was given another roentgen-ray treatment on June 8, by Dr. Gottlieb. The treatments were then changed from roentgen therapy to radium, and in August he had had three treatments at the Radium Sanatorium and Institute, New York City, about eighteen days apart, the total dosage being 7,000 mg-hr. At the end of this time, he had no headaches and felt quite well with the exception of occasional vomiting. He was given two further treatments of 400 mg. for sixteen hours each in September. After each treatment his symptoms would be worse for a few days and then improvement came rapidly. Until Nov. 11, 1920, he was much improved and was able to walk with greater steadiness and engaged actually in outdoor sports with other boys. Early in November, however, he began again to have vomiting, headache, difficulty in gait, so that on Nov. 15 he was unable further to rise from his bed.

He re-entered the hospital on Nov. 22, 1920, Surg. No. 13571. At that time there was marked bulging of the suboccipital decompression, bilateral choked discs with an elevation of 3 D., bilateral external rectus palsy, marked nystagmus on looking to the right and left, dysarthria and dysphagia and very marked incoördination of all extremities of cerebellar type. He was unable to stand. It was not considered that surgical treatment offered any chance of improvement for his condition and on Dec. 3, 1920, he was discharged. He died on March 9, 1921, having gradually declined from the time of his discharge. Necropsy was not obtained.

Impression. It is difficult to judge the effect of the first series of roentgen treatments, for some improvement had followed the decompression. However, when he was discharged from the hospital he still had choked discs of $2\frac{1}{2}$ D., and it is not likely that the decompression alone would have succeeded in completely relieving him for as long a period as seven months. When headaches and vomiting returned (June, 1920) they were definitely relieved after the immediate but temporary exaggeration which is so often seen. Roentgen rays and radium seem to have been equally successful in this case in relieving the symptoms and also in prolonging life although they did not prevent a recurrence and death.

CASE 3. Surg. No. 11785. *Medulloblastoma of cerebellum. Suboccipital extirpation. Roentgen therapy, T. 97. Spinal implant. Laminectomy. Radium therapy. Death three years after onset. Necropsy.*

N. O. B., aged twenty-seven, was admitted Jan. 8, 1920, complaining of headache, vomiting and failing vision, having been referred by her husband, a physician. She had been well up to September, 1918, when she began to complain of headache. Being pregnant at the time it was thought this was the cause, but she continued to complain of severe headaches

which were thought finally, when no sufficient cause could be found, to be hysterical in character. After delivery the headaches and vomiting continued. In December, 1919, she complained of double vision. Two weeks before admission her eyesight began to fail and it was discovered that her optic discs were choked.

On admission to the hospital, it was found that she had bilateral choked discs of 5–6 D., a right abducens palsy, and nystagmus on looking to right and left. Her gait was slightly unsteady. There was some slight incoördination of the left arm and leg of cerebellar type. She had in the hospital a severe attack of headache with retraction of the head and rigidity of the extremities, followed by forced vomiting.

On Jan. 10, 1920, Dr. Cushing did a suboccipital operation disclosing a tumor in the left cerebellar hemisphere. It was possible to brush the cerebellum away from the tumor, although the growth was rather soft, and it was apparently removed in its totality. The wound was carefully closed and the patient made an excellent recovery. She was discharged on Feb. 2, markedly improved. Her choked discs had subsided; headaches, nausea, vomiting and convulsions had entirely ceased. The cerebellar symptoms had also disappeared. Her husband wrote that she felt very well and was free from symptoms until July, 1920, when the suboccipital headaches reappeared. In August she began to stagger in walking. At the same time severe vomiting and headache occurred. After that she was completely bedridden. About the middle of August dysarthria was noted.

She was re-admitted to the hospital on Aug. 24, 1920, Surg. No. 13038, at which time there was found slight edema of the optic discs, slight nystagmus on looking to the right and left, dysarthria, staggering gait, fullness of the suboccipital region and very slight incoördination of the extremities, more marked in the left hand. On Aug. 31 she was given a roentgen-ray treatment, 40 ma-min., 8 in. distance, 130 kv. and 5 mm. aluminum filter. On Sept. 4, her headaches and nausea were gone and she wanted to be up and around the ward. On Sept. 21 she had another roentgen-ray treatment with the same dose, with very marked subjective improvement. On Sept. 22 she was discharged, with vomiting and headaches relieved; there was still some dysarthria and in general her neuroglogical findings were but slightly improved. The most definite objective improvement was to be seen in the suboccipital region, which was much less tense and bulging. Her improvement continued until November when she began to complain again of suboccipital pain. On Nov. 24 she was given a radium treatment which caused vomiting for some ten days afterwards. In January, 1921, she developed symptoms of a spinal lesion and on March 9, 1921, a spinal tumor was removed by Dr. Elsberg of New York City, but she continued to be in a very bad condition. She was given a series of radium treatments over the spine with no improvement in her spinal symptoms. Symptoms of intracranial tension also persisted for which a callosal puncture was done by Dr. K. Winfield Ney of New York City. On the 28th of November, 1921, she died. Necropsy was done on both head and spinal canal; some tumor was found in the cerebellum but none in the spinal region, the necropsy being limited to opening the laminectomy incision.

Impression. The roentgen treatments given in this clinic in September, 1920, were followed by definite though transitory improvement. Radium therapy produced no clinical improvement of the spinal lesion. In comparison with Cases 1 and 2 it is interesting to note that although the cerebellar tumor was apparently completely removed, the symptoms recurred in six months, no roentgen treatments having been given after this operation.

CASE 4. Surg. No. 13981. *Medulloblastoma of the cerebellum. Suboccipital exploration. Roentgen therapy, T. 155. Secondary operation to relieve symptoms of acute intracranial tension following roentgen treatment. Extirpation of tumor. No subsequent roentgen treatment. Recurrence in nine months. Third operation. Death five months later. No necropsy.*

J. H., aged six, was admitted Feb. 9, 1921, complaining of vomiting, headache and unsteady gait, having been referred by Dr. E. Koplik of New York City. He had been well until a year and a half before admission when he began to have attacks of vomiting. For eight months he had internal squint of the left eye; for seven months frontal headache, and convulsive attacks in which he would become unconscious and rigid with head retracted. In September, 1920, staggering gait was noticed.

On admission, there was found a cracked-pot sound on percussion of the skull, incoördination of the extremities of cerebellar type, bilateral choked discs with an elevation of 4 D., unsteady gait, nystagmus on looking to the right and left and paresis of the left external rectus muscle.

On Feb. 14, 1921, Dr. Cushing did a suboccipital exploration. A tumor was disclosed in

the midline projecting down inside the posterior cistern through the foramen magnum. It was necessary to remove the arch of the atlas after which the tumor could be tilted out of the canal. The tumor seemed to be attached at the calamus scriptorius. The lower portion of the tumor was removed; the bleeding checked, and the wound closed. The patient recovered promptly; the choked discs subsided; and on the 5th of March he was walking around the ward. He was given a roentgen-ray treatment on March 8, 32 ma-min., 9 in. distance, 130 kv., through 5 mm. Al filter. Treatment was followed by vomiting for twelve hours. He was discharged on the 11th of March with headaches and vomiting relieved, fundi subsided to 1 D., and his gait steadier than on admission. His other symptoms were unchanged. He was given three further roentgen treatments by Dr. I. Seth Hirsch of New York City on April 8, May 3 and May 27, 1921, 32 ma-min., gap 9 in., filter 6 mm. Al; and his symptoms seemed to be so completely relieved that no further treatments were given. On July 16, 1923, he was examined and it was found that the optic discs were flat. There were a few nystagmoid jerks on looking to the right and left. There was no ocular paresis. There was a little unsteadiness in gait and some slight hypermetria of the left arm.

He continued quite well until the 1st of March, 1925, when he had a slight headache and vomiting, and was re-admitted to the hospital March 10, 1925, Surg. No. 23390. At that time there was found a bilateral secondary optic atrophy, nystagmus on looking to the right, left and upwards; his gait was slightly staggering. There was some slight ataxia of the left extremities. He had two attacks of vomiting in the hospital, but he had so few symptoms that it was finally decided to give him a roentgen-ray treatment and allow him to go home. Treatment was given on March 23, with a full dose, technique "A," followed by vomiting during the evening. At 5 o'clock on the morning of March 24 it was found that he was unconscious. In the course of a few hours he began to have Cheyne-Stokes respiration. He was consequently taken to the operating room and the suboccipital region was re-explored by Dr. Cushing. It was found that the suboccipital decompression had been completely closed over by new bone. On opening the dura, there was found a soft, centrally placed tumor which was removed apparently *in toto*, leaving a huge central cavity, in the bottom of which fluid could be seen pouring out of the aqueduct of Sylvius. The wound was closed and, although the patient had a postoperative hyperthermia, he rapidly recovered.

He was discharged on April 18, 1925, at which time he was without headaches or vomiting; his fundi were flat; he had a marked nystagmus, slight dysarthria, a very marked cerebellar incoördination of all his extremities and unsteady gait, although he was able to walk alone. It was decided that he should have no more roentgen treatments unless he had a recurrence of symptoms. On June 6, 1925, his father wrote that he had improved somewhat, being able to walk better and there was no recurrence of headaches or vomiting.

In September his gait became unsteady. In October he complained of pain over his left eye. There was occasional nausea and an internal squint of the left eye. On Dec. 21 he had a severe headache. Since this date there was almost continuous headache, and occasional vomiting and attacks of opisthotonus. He was re-admitted to the hospital Dec. 24, 1925, Surg. No. 25444.

There was found on examination a tense suboccipital region, bilateral choked discs, paralysis of the left abducens nerve, hypesthesia of right trigeminal area, paresis of the right temporal and masseter muscles, deafness of the right ear, sluggish pharyngeal reflexes, deviation of the tongue to the right, staggering gait, nystagmus and asynergy of all the extremities.

On Jan. 4, 1926, the suboccipital region was again explored. There was a large irregular cyst of the right cerebellar region, in the walls of which were masses of soft neoplastic tissue. The whole right cerebellar fossa was filled with tumor, a great portion of which was removed, but his condition was so poor that the attempt at complete extirpation was abandoned.

He recovered promptly. Headaches were relieved and the choked discs subsided. On Jan. 15 an attempt was made to extirpate the tumor. The fourth ventricle was opened and a radical extirpation carried out, leaving only the portion attached to the cranial nerves on the right side.

He improved slowly after this operation, but by Feb. 10, 1926, he could walk about with support. He was discharged Feb. 16, at which time there was still paresis and hypesthesia of the right fifth nerve, dysarthria, asynergy of all extremities, paresis of right sixth nerve. He was free from headache and vomiting.

He died on May 31, 1926, having gradually failed following his discharge.

Impression. The long freedom from symptoms after the first operation cannot be explained as an effect of the operation alone, for only a fragment of the tumor was removed and histologically it was a typical medulloblastoma with numerous mitotic

figures. It might be considered from the clinical history before operation that the tumor was of lower malignancy than the average medulloblastoma, but the slightly longer pre-operative course may in part be explained by spontaneous decompression from separation of the cranial sutures. An interval of four years between operation and recurrence must, in our opinion, be attributed to the effect of roentgen therapy, the more so since, following the second operation when a radical extirpation was done, completely relieving his symptoms (no roentgen treatment being given), there was recurrence in nine months. The untoward effect of the roentgen treatment on March 24, 1925, must be attributed to the fact that the suboccipital decompression had been completely recovered with new bone, thus leaving no room for sudden expansion due to edema, and is an indication of what may happen if such a case is treated without preliminary decompression. In view of our present knowledge, recurrence could probably have been retarded after the second operation, had vigorous roentgen treatment been instituted.

CASE 5. Surg. No. 16059. *Medulloblastoma of the cerebellum. Suboccipital operation. Secondary operation three months later. Roentgen therapy, T. 369. Third operation. Death nine months later. No necropsy.*

D. L. S., aged ten, was admitted Feb. –, 1922, complaining of headache, vomiting and staggering gait, having been referred by the Children's Hospital, Boston. The child had been well until Nov. 2–, 1921, when she began to complain of severe suboccipital headache. Her mother thinks she had been clumsy for about one year before that. During the last three weeks the headaches had increased in severity; she had been vomiting often and was very irritable. She had difficulty in walking, from the onset, and her handwriting became very unsteady.

On admission there was found a cracked-pot sound on percussion of the skull, bilateral choked discs of 2–3 D. elevation, coarse nystagmus on looking to the right and left, staggering gait, incoördination of all the extremities of cerebellar type and tenderness of the suboccipital region.

On Feb. 13, 1922, Dr Horrax did a suboccipital exploration. The right hemisphere seemed a little fuller and was found to contain a large cyst from which 50–60 c.c. of fluid was obtained. Patient recovered promptly and was discharged on March 12, 1922, free from headache and vomiting. The optic discs had subsided; cerebellar symptoms still present but less marked.

She was re-admitted to the hospital May 24, 1922, Surg. No. 16690. In the interval she had at first improved greatly, but in the last six weeks headaches had again appeared; the suboccipital region became prominent, and her gait very unsteady. Examination at this time showed a markedly bulging suboccipital region, elevation of the optic discs of 3–4 D., and a pronounced cerebellar syndrome.

On May 27, 1922, Dr. Horrax again explored the suboccipital region and partially extirpated a large soft central cerebellar tumor. There was no cystic cavity. There was considerable bleeding which was checked with difficulty and the wound closed. The patient recovered and was discharged on June 21, 1922; headaches and vomiting were relieved but the cerebellar symptoms were unchanged. Discs were still elevated 2 D. She was given one roentgen-ray treatment before discharge on June 21, 125 ma-min., technique "A." Other treatments were given on July 12, Aug. 12, Aug. 23, Sept. 13, 150 ma-min.; Oct. 4, Nov. 22, Dec. 13, 1922 and Jan. 10, 150 ma-min.; Jan. 31, 150 ma-min.; April 21, 150 ma-min.; May 11, 150 ma-min.; June 1, 150 ma-min., and June 22, 1923, 150 ma-min.

She improved rapidly and had no headache or vomiting until April, 1923. After that time headaches gradually returned; her gait became more unsteady, and she had occasional vomiting. On July 13, 1923, it was found that she had a bilateral secondary atrophy with no swelling. Her gait had improved but was still very unsteady. There was marked hypotonicity of all the extremities. She had been vomiting persistently for the last two weeks. The roentgen treatments were discontinued.

She was re-admitted on July 27, 1923, Surg. No. 19337. There was found to be bilateral secondary optic atrophy, nystagmus on looking to the right and left, general hypotonicity and incoördination of all the extremities, and marked staggering gait. She was barely able to walk alone and the suboccipital region was tense and bulging.

On Aug. 2, Dr. Horrax explored for the third time the suboccipital region and removed tissue involving mainly the right hemisphere. This tumor contained small cystic cavities. The child recovered from the operation. On Aug. 15 she received a roentgen-ray treatment at only 90 ma-min., technique "A," which resulted in an increase of headaches, rise of temperature and vomiting, so that on Aug. 24 it was neces-

sary to give her intravenous saline to reduce intracranial tension. From then on she improved slightly and was given a second roentgen-ray treatment on Sept. 7, full dose, 150 ma-min. This second treatment seemed to produce improvement in her condition for she became brighter and was able to get up and walk about, although quite unsteady on her feet. She was discharged on Sept. 16, feeling fairly well, walking with a marked staggering gait and having occasional headache and vomiting. From that time on she gradually failed and although she was given two more roentgen treatments, Oct. 10 and Nov. 5, each of 100 ma-min., she finally died on Nov. 20, 1923. Necropsy was not obtained.

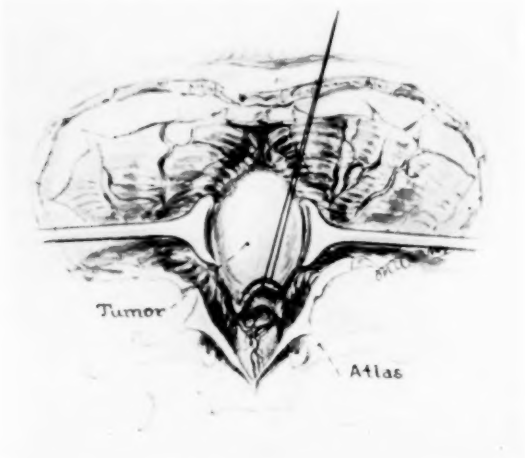

Fig. 1. Case 6. Showing typical location of medulloblastoma in the cerebellum over the 4th ventricle, as exposed at operation.

Impression. After evacuation of the cyst the symptoms recurred in six weeks and this recurrence, as proven at the second operation, was not due to refilling of the cyst. No roentgen treatment was given during this time. After the second operation with subsequent roentgen therapy the period of relief was increased to ten months, but the symptoms slowly returned even during treatments. After the third operation treatments produced only slight and transitory improvement and one on Aug. 15 caused a very severe reaction.

Case 6. Surg. No. 17428. *Medulloblastoma of the cerebellum. Suboccipital exploration. Roentgen therapy, T. 425. Spinal implant. Laminectomy. Death five months later. No necropsy.*

H. M., aged five, was admitted Sept. 25, 1922, complaining of headache, vomiting and difficulty in walking, having been referred by Dr. I. S. Wechsler of New York City. His illness began six weeks before admission with pain in both sides of the face. About a week later he had a furuncle in his left nostril, and after it had disappeared the parents noticed that he held his head tilted to the right side and staggered in walking. About a month before admission he began to complain of headaches and had projectile vomiting.

On examination there was found bilateral early choking of the optic discs with no measurable elevation; his gait was staggering and he had incoördination of all his extremities of cerebellar type. There was also paresis of the left sixth nerve but no nystagmus.

On Sept. 30, 1922, Dr. Cushing explored the suboccipital region. A tumor was found occupying the center of the cerebellum (Fig. 1). It was impossible to free the tumor and remove it *in toto*, so that a mass about the size of the end of the thumb was removed from its lower portion. The child had a marked hyperthermia following the operation but recovered rapidly and was discharged on Oct. 31, feeling quite well; headaches and vomiting were relieved; optic discs were completely subsided, and he was somewhat steadier in walking than on admission. He was given one double roentgen-ray treatment on Oct. 27, 1922, with 125 ma-min. to the left half of the cerebellar area and 100 ma-min., technique "A" to the right half. This caused him only slight headache and vomiting the following day. The roentgen-ray treatments were continued by Dr. Samuel Stern of New York City. He received five treatments in all over the cerebellum, on Nov. 17, Dec. 23, 1922, and Feb. 10 of 57 ma-min., and March 24, and May 21, 1923, with 60 ma-min., all with 200 kv., 30 cm. distance, 0.5 mm. Cu + 2 mm. Al filter, and for more than a year was entirely free from symptoms. About the 1st of February, 1924, he began to complain of pain in the right axilla and a week later it was noticed that he had difficulty in walking.

He was re-admitted on March 7, 1924, Surg. No. 20887. On admission it was found that his discs were flat; there was a paresis of the right external rectus muscle, and the patient was unable to stand or walk alone. He was incontinent of urine. He had a paraplegia with hypesthesia to pinprick below the level of the 3d dorsal spine which developed rapidly following admission. He was given a roentgen-ray treatment over this region on March 19, of 108 ma-min., 10 in. distance, 135 kv., and 0.5 mm. Cu filter, which produced no change in his condition. On March 17, the cerebellar region

had also been irradiated with a full dose, technique "A." On March 25, 1924, Dr. Cushing did a laminectomy, disclosing at the level of the 5th thoracic vertebra a cuff of tumor inside the arachnoid completely surrounding the spinal cord. By blunt dissection a mass about 2.5 cm. in length by 1 cm. in breadth was removed from the posterior surface of the cord. The patient recovered rapidly from the operation. There was no change in his paraplegia. On April 9 he was given a roentgen-ray treatment to the spine, same dose, which produced no reaction and he was discharged on April 11, with a complete paraplegia. The roentgen treatments of the spinal region were continued by Dr. Stern; April 30 and June 4, 1924 of 100 ma-min., 200 kv. 30 cm. distance, and 0.5 mm. Cu + 2mm. Al filter, but without any effect upon his condition. He died on August 24, 1924. There was no necropsy.

Impression. The intracranial pressure symptoms were completely relieved by the operation, but it is probable that the roentgen treatment retarded local recurrence for, until his discharge on April 11, 1924 (nineteen months) there were no signs of intracranial tension. Presumably he died from the effect of the spinal lesion, our information not being very exact concerning the cause of death. It is strange, in the light of our later experience, that the spinal implants were not influenced by treatments. It may possibly be that the cord in this case had been too severely damaged before treatments were begun.

CASE 7. Surg. No. 1-669. *Medulloblastoma of the mesial surface of the right cerebral hemisphere. Osteoplastic exploration with decompression. Radium treatment. Subsequent roentgen therapy. Death nineteen months after operation. No necropsy.*

J. A. M., aged thirty, was admitted Oct. 31, 1922, complaining of twitching and weakness of the left foot, having been referred by Dr. Chas. Dowman of Atlanta, Ga. His illness began in August, 1920, when he woke at night in an epileptic attack. These attacks recurred at intervals, beginning with twitching in the left foot progressing to the left leg and arm and often accompanied by loss of consciousness. Following an attack in August, 1922, he noticed a weakness of the left foot. This weakness became permanent.

On examination there was found a left hemiparesis and hemihypesthesia with exaggeration of the tendon reflexes on the left side of the body, diminution of abdominal and cremaster reflexes on the left side, and clonus at the left ankle. All of his symptoms were more marked in his left foot. The fundi were practically normal.

On Nov. 10, 1922, Dr. Cushing turned down a bone flap over the right central region and disclosed on the mesial side of the right hemisphere a soft, sharply demarcated glioma. A fragment was taken for microscopic examination and the wound closed. Two standard platinum needles containing 12.5 mg. of radium chloride were left in the tumor for twenty-four hours. The next day the patient was very stuporous; was vomiting and incontinent; and his optic discs showed some choking. From that time on he improved steadily and was discharged on Nov. 30, his condition being practically the same as on admission. He thought that there was some slight improvement in the strength of his left hand and foot.

He was given roentgen therapy by Dr. J. J. Clark of Atlanta, Ga. On Jan. 30, 1923, he was given 90 min. each over the right and left parietal regions, 130 kv., 5 ma., 0.5 mm. Cu + 1 mm. Al, 16 in. skin target distance. There was complete epilation by Feb. 15. He felt himself greatly improved; convulsions ceased. Similar treatments were given in March, May and July. He was in excellent health when treatments were stopped.

On Aug. 7, 1923, he was examined and found to be vigorous and well, but still having frequent Jacksonian attacks in his left leg and arm. His optic discs were normal and there was almost no trace of hemiparesis. His left grasp was 140 and his right 145, which would be considered normal had he not been left handed and previously much stronger in his left arm than in his right.

On Nov. 16, 1923, he had a severe epileptic attack and was again treated by roentgen rays in January and February, 1924, presumably with the same technique. During this period he had dizzy spells, with tingling and cramping in his foot. He was nervous and difficult to control. From this time he failed steadily and by April 1, 1924, he had a complete left hemiplegia and died June 24, 1924. There was no necropsy.

Impression. His general condition improved and convulsive attacks ceased during the series of treatments given in 1923 (February to July). It is possible that his life was prolonged since an interval of nineteen months is considerably above the average to be expected from operation alone in this class of tumor. The radium on Nov. 22, 1924, apparently caused a definite reaction but this is confused by

the operation of the same date. The longer than usual preliminary symptoms may be explained by the fact that the tumor developed in the central gyrus giving almost immediate focal symptoms. He had not developed pressure symptoms up to the time of the first operation.

CASE 8. Surg. No. 18793. *Medulloblastoma of the cerebellum. Suboccipital exploration. Roentgen therapy, T. 555. Death twelve months after operation. No necropsy.*

R. M., aged two, was admitted May 9, 1923, complaining of headache and vomiting, having been referred by the Children's Hospital, Boston. She had been well until February, 1923, when she complained of headache and had frequent vomiting. She became very unsteady in walking and for seven weeks had been unable to walk at all.

On admission there was found a cracked-pot sound on percussion of the head, bilateral secondary optic atrophy with elevation of the left disc of 2 D., intention tremor of both hands, exaggeration of tendon reflexes, with an ankle clonus and a positive Babinski sign on the left side. Her extremities were quite weak and ataxic.

On May 16, 1923, Dr. Horrax did a suboccipital exploration and disclosed a large tumor occupying the whole middle portion of the posterior fossa, pushing the cerebellar hemispheres far to each side. An attempt was made to get around it, but the child's condition becoming unsatisfactory, the attempt was abandoned; some pieces of the tumor were removed for examination, and the wound was closed. The child recovered promptly. She was given a roentgen-ray treatment on June 7, of 120 ma-min., technique "A." She had been improving steadily and the roentgen treatment did not seem to hasten her improvement. A second treatment was given on June 23 of 90 ma-min. at 10 in. distance, technique "A." She was discharged on June 24, being able to sit up alone but unable to walk because of marked incoördination of the lower extremities. Her fundi showed marked secondary optic atrophy without choking. Vomiting had been relieved and she did not complain of headaches. Another treatment was given July 16, 1923, of 100 ma-min. at 10 inches, when her general condition seemed much improved. She was bright and alert. She returned for a fourth treatment on Aug. 6, 1923, when she was less well and so irritable and uncoöperative that it was impossible to give her treatment.

She did not again return, but failed steadily and died May 1, 1924.

Impression. The early improvement may be attributed to the operation. By the time of the fourth treatment her condition was again definitely progressing under treatment, and she was subsequently too ill to be brought to the clinic. The treatments that were given were unsatisfactory because of lack of coöperation, so that we were not sure what portion of each dose reached its mark. No definite benefit from roentgen therapy can be seen.

CASE 9. Surg. No. 18901. *Medulloblastoma of the cerebellum. Suboccipital decompression. Roentgen therapy, T. 578. Secondary operation with partial extirpation. Death the following day. Necropsy.*

H. MacD., aged twelve, was admitted May 25, 1923, complaining of dizziness, vomiting and double vision, having been referred by Dr. Thomas Burrage of Portland, Maine. She had been well until May, 1922, when she began to have attacks of dizziness and vomiting. The attacks continued until two months before admission when they became so persistent that she was obliged to leave school. For two weeks she complained of double vision.

On examination it was found that she had bilateral choked discs of 4–5 D., slight nystagmus on looking to the right and left, marked hypotonicity of all the extremities and some slight unsteadiness in walking.

On June 18, 1923, Dr. Cushing did a suboccipital exploration without finding a tumor. Patient recovered promptly. Choked discs subsided to about ½ D. She was up and about the ward without headache or vomiting. Cerebellar symptoms were practically unchanged. She was given a roentgen-ray treatment on July 3, full dose, technique "A," without any apparent effect. On July 8 she was discharged. She was then free from headache and vomiting and her choked discs had subsided completely. The other symptoms were unchanged. She returned on Aug. 7 for a second similar roentgen treatment, in practically the same condition.

She continued well until Jan. 3, 1924, when she had headache and vomiting. At this time it was found that she was still somewhat unsteady in walking; had persistent nystagmus on looking to right and left; the optic discs were edematous and elevated 1½ D.; the suboccipital area was bulging but not particularly tense. She was given a third similar roentgen treatment on Jan. 3. The treatments were continued on Feb. 5, Mar. 7, Apr. 9 and May 10, 1924, by Dr. F. W. Lamb of Portland, Me., using 9–10 in. spark gap, 150 ma-min., 12 in. distance through 0.25 mm. Cu. During this time her condition steadily grew worse. After

March, 1924, she gradually became weaker and more unsteady on her feet. In March and again in May she had convulsive attacks with opisthotonus and unconsciousness and on June 19, 1924, she was re-admitted to the hospital, Surg. No. 21585.

At this time the suboccipital region was found to be full; the optic discs were choked, 3 D.; there was coarse nystagmus on looking to the right and left, and she was unable to stand or walk alone. Frequent opisthotonoid convulsions occurred.

On June 27, 1924, Dr. Horrax re-explored the suboccipital region and, transecting the cerebellar cortex to a depth of 3 cm., came upon a small nodular tumor, a large portion of which was removed. There was considerable bleeding which seemed to be well arrested and the next day she seemed to be doing well, but at 7 o'clock on June 28 she rapidly became worse and soon died. Necropsy was performed which showed considerable edema of the cerebellum and medulla oblongata and a large blood clot occupying the center of the cerebellum (Fig. 2).

Impression. The early improvement was due to the decompression. It is to be noted that only two treatments were given following the first operation and symptoms recurred at about the interval expected without treatments, viz., six months. When treatments were again started after the recurrence, January, 1924, little improvement was obtained but operation was in this way postponed for six months so that treatments may have retarded the growth even under these unfavorable conditions.

CASE 10. Surg. No. 19386. *Medulloblastoma of the cerebellum. Suboccipital extirpation. Roentgen therapy, T. 617. Spinal implant. Death about a year after onset of symptoms. No necropsy.*

J. H. T., aged twenty-one, was admitted Aug. 6, 1923, complaining of headache and dizziness, having been referred by Dr. J. W. Fitzgerald of Milton, Mass. He had been well until six weeks before admission when he began to have frequent headaches. For three weeks he had been nauseated but had not vomited. He was also very dizzy. Since the headaches were worse on arising, he had remained for some days in bed.

On admission there was found to be a persistent nystagmus on looking to right and left, a slight tendency to stagger on walking or turning sharply, early choking of the discs of about 1 D. elevation, and on Aug. 20 a ventriculogram was made, which showed a symmetrical dilatation of the ventricles. On Aug. 22 a suboccipital exploration was done by Dr. Horrax and a large central cerebellar tumor was found in which was a small cyst; a large portion of the tumor was removed. Patient recovered well and on Sept. 7 was given a roentgen-ray treatment to the cerebellar area, full dose, technique "A." On Sept. 15 he was discharged. His headaches were relieved and the choked discs had subsided. He was similarly treated on Oct. 1, Oct. 22, Nov. 12 and Dec. 3, 1923, and continued to feel well until Jan. 21, 1924, when he commenced again to have nausea and vomiting and occasional headaches, and did not report for treatment. On March 20 the suboccipital area was tight and his optic discs were slightly blurred.

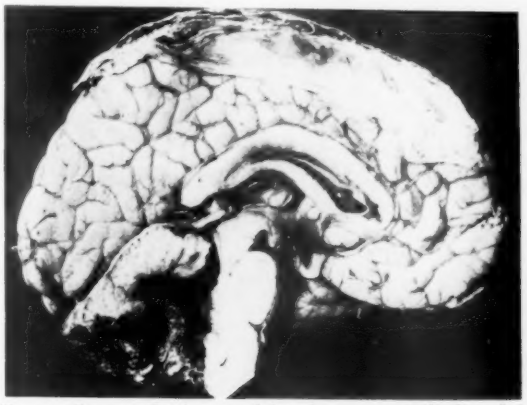

FIG. 2. Case 9. Cavity resulting from removal of medulloblastoma of the cerebellum. A portion of the tumor is still attached to the floor of the 4th ventricle.

He was re-admitted on March 28, 1924, Surg. No. 21033, at which time it was found that the suboccipital region was tense; there was nystagmus on looking to the right and left, incoördination of all the extremities of cerebellar type and a low grade choking of 1 D. On April 3 he was given a roentgen-ray treatment over the cerebellar area of 162 ma-min., technique "A," which was followed by nausea and vomiting and severe frontal headache. On April 17, on account of his complaining of pain in the lumbar region, there was found a definite patch of anesthesia over the left buttock. A lumbar puncture was done which disclosed xanthochromic fluid. He was given a roentgen-ray treatment on April 17 over the lumbar region of 150 ma-min., technique "A," and on April 30 was discharged.

He was re-admitted on May 8, 1924, Surg. No. 21315, complaining of shooting pains in his right leg and shin. The same patch of

anesthesia corresponding to the 4th and 5th sacral areas on the left side was found. Treatment was given over the lumbosacral area on May 8, full dose. The roentgen-ray treatments had no effect upon the pain or the area of anesthesia. Examination showed bilateral choking of the optic discs of 1–1½ D., coarse nystagmus on looking to the right and left, and a bulging suboccipital region. He was given a roentgen treatment on May 22 over the suboccipital region, full dose, technique "A," and discharged. His symptoms were unrelieved and he died soon afterwards, the exact date being unknown.

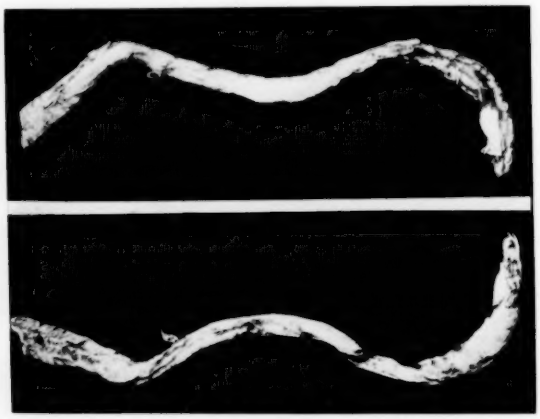

FIG. 3. Case 11. Spinal cord with gravity metastases from a medulloblastoma of the cerebellum. Dorsal surface above; ventral surface below.

Impression. It is not apparent that roentgen therapy altered in any way the course of this patient's malady. The treatment on April 3, 1924, was followed by a moderate reaction.

CASE 11. Surg. No. 23932. *Medulloblastoma of the cerebellum. Suboccipital exploration. Roentgen therapy, T. 106°. Spinal implant. Marked improvement for a time, then gradual failure and death. Necropsy.*

F. T., aged eleven, a schoolboy, was admitted to the hospital referred by Dr. V. A. Reed of Lawrence, Mass., complaining of headaches and vomiting.

He had always been well, except for a cervical adenitis at the age of six, until about September, 1924, when he began to have frontal headache. In April, 1925, he was tired and once vomited. Towards the end of April he found it difficult to read because his vision was blurred. During the month of May he was in bed with severe headaches, repeated vomiting, and attacks of pain in the back of the neck during which his head was retracted. When he tried to walk he was more unsteady than seemed justified by his long confinement to his bed.

He was pale and emaciated on admission, lying in bed with his head retracted. There was found a cracked-pot sound on percussion of the head. There was slight suboccipital tenderness to pressures and flexion of the head on the chest caused pain. The optic discs were elevated 2 D. His gait was staggering, with a tendency to fall to the right and backwards. There was marked hypotonicity and asynergia of all the extremities, nystagmus on looking to right and left, and a bilateral Babinski sign.

On May 20, 1925, Dr. Cushing did a suboccipital exploration and disclosed a tumor mainly in the right cerebellar hemisphere, projecting down through the foramen magnum so that it was necessary to remove the posterior arch of the atlas. The tumor, which weighed 31 grams, was removed fairly intact in one large mass. There was a slight postoperative hyperthermia, after which his convalescence was rapid. His headaches and vomiting were completely relieved; the swelling of the optic discs subsided and he was able to walk well without assistance. Roentgen-ray treatment was given on June 12 of 120 ma-min., technique "A," and he was discharged on June 23, 1925.

He was given a series of roentgen treatments July 16, Aug. 7, Aug. 28, Sept. 18 and Oct. 9, 1925, each to the cerebellar area, full dose, technique "A." When examined on Dec. 28, 1925, he was perfectly well. There were absolutely no symptoms of cerebellar disturbance; he had been playing football and other games as though he had never been ill.

On Oct. 12, 1926, he returned for examination complaining of pain in the chest, increased by coughing or breathing deeply. There was found a band of hypesthesia at the level of the 4th thoracic segment. He was re-admitted to the hospital, Surg. No. 27429, on Oct. 15, 1926.

There was no evidence of recurrence of his cerebellar tumor, but at the level of the 3d and 4th thoracic segments was a band of analgesia, and below this level hypoalgesia and loss of temperature sense on the right side. On the left side were found exaggeration of the tendon reflexes of the leg, a defense reflex, tendency to ankle clonus, and Babinski sign. He complained also of pain and stiffness of the neck. Since it was supposed that there must be a spinal implant from the cerebellar tumor, he was given roentgen-ray treatment over the cerebellar, cervical and upper dorsal regions, Nov. 4, full dose, technique "A," which was followed by vomiting and headache. Headache and pain in the neck disappeared quickly

and he was up and around the ward; his spinal symptoms seemed slightly improved. On Nov. 27 he was given another treatment over the cerebellar, cervical and upper dorsal regions, same dose, with very little reaction and on Dec. 31, 1926, he was discharged. There was epilation over the suboccipital region but no swelling nor rigidity. His spinal symptoms were, however, even more marked than on admission. There was a very definite clonus of the left ankle and he dragged the left foot in walking.

On Dec. 20, he had gained 9 pounds. There had been no vomiting nor headache. Left leg still very weak and spastic. Walking with spastic hemiplegic gait. Optic discs flat. Ninth roentgen-ray treatment given to cervical spine and cerebellar area, full dose, technique "A."

By Jan. 1, 1927, he was unable to walk because of weakness of the legs. Roentgen-ray treatment of the occipital and cervical regions was given Jan. 10, 1927, full dose, technique "A."

He was re-admitted on Jan. 31, 1927, Surg. No. 28122. There was no evidence of recurrence of his cerebellar tumor, but there was a spastic paraplegia with a band of anesthesia at the level of the second dorsal segment and another at about the tenth dorsal, below which was an irregular anesthesia affecting both lower extremities. The upper abdominal reflexes were present, the lower absent. Obstinate constipation and occasional incontinence of urine.

He was given roentgen-ray treatment on Jan. 31, full dose, technique "A," over the spine from the 6th cervical to the 10th dorsal segments. He was nauseated and vomited for several days following. On Feb. 2 treatment was given to the spine from the 10th thoracic to the sacral region, 80 per cent dose, technique "A."

He was somewhat improved following this treatment. Incontinence ceased. Was walking with assistance. There was a definite level of anesthesia at the 3d dorsal segment when examined on Feb. 24. Treatment of the entire spine was given on this day, with 180 ma-min., 135 kv., 16 inch distance through 5 mm. Al. The treatment was again followed by nausea and vomiting for a few days.

On March 18 he was examined. The improvement was striking. He walked with only slight spasticity and had been playing golf. Very little sensory loss could be determined in the lower extremities. The optic discs were flat and the suboccipital region was not bulging. He felt quite well. The entire spine was again treated causing nausea and vomiting for a few days.

By April 15, 1927, there was still further improvement. *His gait was normal. He had been running and playing baseball like a normal boy.* The tendon reflexes were exaggerated in the left leg, but strength was practically normal. No sensory level could be found. The lower dorsal and lumbar regions were treated as on Feb. 24, again followed by vomiting.

On May 11, 1927, he reported complaining of pain over the right eye and vomiting. He looked pale and listless. There was no change in his spinal symptoms. Although there was no choking of the optic discs and no bulging of the suboccipital region, it seemed probable that there was a recurrence of the cerebellar tumor so the suboccipital area was treated, with 138 ma-min., 135 kv., 14 inch distance, through 5 mm. Al. (The last three of the fifteen treatments were given at the Collis P. Huntington Hospital while our department was being rebuilt.) He died June 17, 1927, at home. Necropsy, which was restricted to the spinal cord, showed areas of diffuse fibrosis in the leptomeninges from the 4th thoracic region downwards to the cauda equina (Fig. 3), with only a few islands of tumor remaining.

Impression. The effect of roentgen therapy in this case was very favorable in two ways: (*a*) the cerebellar symptoms did not recur for two years following operation; (*b*) the spinal implant was definitely checked and the symptoms almost entirely alleviated. The treatments, however, were almost invariably followed by reactions and they did not prevent a final fatal outcome.

CASE 12. Med. No. 28682. *Medulloblastoma of the cerebellum. Suboccipital extirpation. Spinal implant. Roentgen therapy, T. 1323. Prompt improvement.*

Joseph M. W., aged eighteen, was admitted to the hospital, Med. No. 28682, Oct. 4, 1926, referred from the Out-Patient Department, complaining of headache and vomiting.

He had always been well until November, 1925, when he began to have vomiting attacks, especially on arising in the morning. For the last two months he had had headache and soreness of the back of the neck. During the last month his gait was unsteady.

It was found on admission that he had bilateral choked discs and he was transferred to the surgical service, No. 27371. Here were found bilateral choked discs of 3–4 D. elevation, suboccipital tenderness, hypotonicity of all the extremities with some slight asynergia of the left hand, nystagmus on looking to either side, gait slightly unsteady.

On Oct. 14, 1926, Dr. Cushing did a sub-

occipital exploration disclosing a midline tumor apparently occupying the whole of the vermis. Beginning at its lower extremity it was apparently dissected out entirely, leaving the 4th ventricle completely exposed.

He recovered promptly, was given a roentgen-ray treatment on Nov. 6, of 150 ma-min., technique "A," and was discharged on Nov. 7, 1926, with symptoms completely relieved except slight hypotonicity of the extremities.

He was examined on Nov. 27, 1926, and found to be quite well. In February, 1927, he returned complaining of a girdle pain in the right lower thoracic region, with numbness and weakness of both legs. There was found spasticity of both lower extremities with exaggeration of the tendon reflexes and a questionable Babinski sign on the left side. There was also hypesthesia to pinprick over the left leg. He was therefore re-admitted to the hospital Feb. 23, 1927, Surg. No. 28266.

On examination there was found hypesthesia up to the 10th thoracic segment predominating in the left leg, weakness and spasticity of the lower extremities, more marked in the right leg. He was unable to walk alone. No urinary disturbance. There were no signs of a recurrence of the cerebellar lesion.

He was given a roentgen-ray treatment on Feb. 26, of 180 ma-min., 16 inch distance, 130 kv. through 5 mm. Al, over the spine from the 3d dorsal to the 2d lumbar, resulting in retention of urine for three days but almost immediate improvement of the paraplegia. He was discharged on March 11, 1927. He had regained considerable power in his legs but was still unable to walk alone. The girdle pain had disappeared.

He was treated again on March 19 over the same spinal area, March 23 over the cerebellum and April 13 over the spinal area again, both spinal treatments the same as on Feb. 26, the cerebellar dose being 138 ma-min., at 14 inch distance.

On April 13, 1927, he was walking without assistance but with some spasticity. There was hyperesthesia below the 10th thoracic level. His fundi showed secondary atrophy but no choking. There was no bladder disturbance and no girdle pain.

On June 22, 1927, his condition was excellent. He was walking well. There was very slight spasticity in the lower extremities, but muscular strength was excellent. There was no sensory disturbance to be found. Bladder function was normal. There were no cerebellar symptoms and no evidence of intracranial tension. He complained of pain in the left shoulder but no sensory disturbance could be found in this region. No treatment was given. A sixth treatment was given July 5, 1927, to the cervical spine and cerebellar areas.

Impression. It is too early to judge the effect on the cerebellar tumor but the spinal implant was promptly and favorably influenced by roentgen therapy after a transitory retention of urine. Unfortunately our experience leads us to suppose that his improvement is not likely to continue long.*

SUMMARY

It would seem definitely proven from the foregoing records that roentgen therapy has been able to retard the growth of a medulloblastoma, sometimes for a considerable period, but that it has been unable to destroy it completely or to prevent its growth indefinitely. In 5 of the 11 cases the interval between operation and recurrence seems to us to have been prolonged; in 4 others clinical improvement was obtained after recurrence had taken place. In 2 patients no improvement was obtained, but one of them was a baby so uncoöperative that proper treatments could not be given. The mere fact that the average survival in these treated cases was thirty-four months is conclusive evidence of the beneficial effects of radiation.

Of the 5 spinal implants clinical improvement was obtained in only 2 instances, but they were both very striking remissions. It may be that in the other 3 cases the damage to the cord was too great before treatment was begun.

Transitory exaggeration of symptoms, nausea and vomiting, often immediately followed the treatments but only once was a serious accident obtained which necessitated immediate operation. It is noteworthy that the decompression in this case had completely refilled with bone before this treatment was given.

In the literature we have been able to find only one tumor which would seem to be certainly a medulloblastoma (Case 3 of Olivecrona and Lysholm.[22]) It seems to have reacted to irradiation much as our own cases did.

*This patient was re-examined Feb. 6, 1928; his spinal symptoms were slight and no level of disturbed sensation could be elicited. He was given two high voltage fractional treatments over the cerebellar area as a prophylactic measure and discharged.

B. SPONGIOBLASTOMA MULTIFORME

These rapidly growing, cellular tumors occur almost exclusively in the cerebral hemispheres of adults. They are anaplastic, undifferentiated growths and run their course in about a year. They are subject to extensive degenerative changes and the blood-vessels which supply them rarely have normal walls so that thrombosis and hemorrhages are common, resulting in the ragged cavities often found at operation or necropsy.

The neoplastic cells have a tendency to assume a spindle shape, remotely resembling bipolar spongioblasts, although many are to be seen forming imperfect astroblasts or astrocytes. There is some evidence that they arise by neoplastic transformation of protoplasmic astrocytes. Many varieties have been described—spindle-celled, giant-celled, ameboid, etc.—but there is no practical advantage in doing so as they are all essentially similar when judged by their behavior, i.e., onset in adult life, location in the cerebral hemispheres, rapidity of evolution, number of mitotic figures, tendency to degenerative changes, etc.

CASE 13. Surg. No. 14895. *Spongioblastoma multiforme of left supramarginal gyrus. Osteoplastic operation. Radium therapy and roentgen therapy, T. 241. Temporary improvement followed by rapid progress of disease and death. No necropsy.*

J. B. R., aged forty-one, was admitted on July 21, 1921, complaining of headache and loss of speech, having been referred by Dr. R. McCready of Pittsburgh, Pa. He had been well until March, 1921, when he began to have intense headaches between the eyes. The latter part of June, 1921, it was noticed that the right side of his mouth drooped. Since July he could not remember the words which he wanted to use. He had become somewhat inattentive and careless, forgetful, irritable and nervous.

On examination there was found a right hemiparesis, a global aphasia and apraxia, exaggeration of deep reflexes on the right and bilateral choking of the optic discs of $1\frac{1}{2}$ D.

On July 23, 1921, Dr. Cushing turned down a bone flap in the left temporal region disclosing a tumor in the supramarginal gyrus. It was soft and not clearly demarcated, but a mass about 6 cm. in diameter was removed. Patient recovered promptly from the operation. On July 29 the right hemiparesis had practically disappeared, and his aphasia and apraxia were also remarkably improved, but he was still unable to write to dictation. He was given a roentgen-ray treatment on Aug. 10, 1921, of 250 ma-min., with 132 kv., at 40 cm. distance through 0.5 mm. copper, with no apparent effect on his symptoms. He was discharged Aug. 12, speaking freely and understanding everything that was said to him but still having some difficulty in writing; the right hemiparesis was practically gone and the choked discs had subsided.

After his discharge from the hospital he continued to improve until Aug. 26, when he had some pain in the left side of his head. From that time he seemed to fail in speech and the use of his hands; his drowsiness returned, and it was for this reason that he was given radium treatment by Dr. Russel H. Boggs of Pittsburgh, Pa., over a period of thirteen days from Sept. 6 to 19. Packs were used, 4×4 cm. in size, containing 200 mg. of radium, crossfiring through 16 different portals of entry at 2 cm. from the skin, and he was given in all 11,300 mg-hr. In the words of Dr. McCready who saw him at that time, "The effect of the radium was marvelous. Within a few hours after the first treatment he was much improved in his speech, gait and the use of his hands. The improvement has progressed from day to day and today, Sept. 19, he has regained all that he lost and shows some improvement in every way except he doesn't appear to improve much in writing and occasionally he is unable to recall figures. He is no longer drowsy." This improvement continued until Oct. 15, when he had another treatment with radium, the details of which are not available. Following this treatment his symptoms became much worse, with first vomiting and pain in his head and more bulging through the cranial opening. This continued to be worse from day to day until Nov. 3, 1923, when he had a convulsion and died in a few minutes. There was no necropsy.

Impression. The results of the first treatment with radium were good; those of the second treatment just as definitely bad.

CASE 14. Surg. No. 14918. *Spongioblastoma multiforme of left temporal lobe. Osteoplastic operation with evacuation of cyst. Secondary operation four months later with partial extirpation of solid tumor. Roentgen therapy, T. 298. Death nine months after second operation. No necropsy.*

T. F., aged forty-six, was admitted July 26, 1921, complaining of epileptic attacks and loss

of speech, having been referred by Dr. Arthur M. Lavaller of Suncook, N. H. He had been well until six weeks previous to admission when he felt some twitching of the muscles of his neck causing his head to turn strongly to the right. He then fell unconscious and had a generalized epileptic convulsion. Ten days before admission he had a second attack, following which his memory had been impaired and he had difficulty in reading.

On admission there was found bilateral choked discs with very slight elevation, complete anomia, a right homonymous defect in the visual fields, right hemiparesis and right hemihypesthesia.

On July 30, 1921, Dr. Cushing did an exploratory operation and there was found in the left temporal lobe a cyst containing about 405 c.c. of fluid. In many places in its wall could be seen nodular tumor masses. One of these was removed, the interior of the cyst was fixed with Zenker's fluid, a subtemporal decompression was made, and the wound was closed. The patient recovered promptly; the choked discs subsided; the aphasic symptoms improved considerably so that he could name some common objects, carry on a conversation and even read the newspaper. On Oct. 31, 1921, he was reexamined. His decompression was flat; he was free from headaches, and the aphasic symptoms were very slight.

He was re-admitted to the hospital on Nov. 14, 1921, Surg. No. 15567. He had been well until the last days of October when he began again to have occasional headache and increasing difficulty in reading, writing and speaking. On examination he was found to have a bilateral choked disc of 4 D., and an almost complete anomia, alexia and agraphia.

On Nov. 18, 1921, Dr. Cushing re-explored the left temporal region and this time found the left temporal lobe to be filled with a solid tumor. There were a few small cystic spaces, but no trace of the large cyst which was found at the first operation. The patient's speech improved slightly following this operation. He was given a roentgen-ray treatment on Dec. 12, 225 ma-min., 140 kv., 30 cm. distance, through 0.5 mm. copper, and was discharged on Dec. 13, able to write, read and to carry on conversation, but still having difficulty in finding his words; with the decompression bulging, and his discs still elevated 1 D. He had seven roentgen-ray treatments by Dr. F. Eveleth of Concord, N. H., the technique employed being 5 ma., 50 min. 0.5 mm. copper, 12 in. distance, 140 kv., on Dec. 26, 1921, Jan. 11, Jan. 24, Feb. 9, Feb. 24, Mar. 10 and April 4, 1922, alternating between two portals of entry, one through the temporal defect, the other through the vertex. He was examined at this clinic in March, 1922. The hair had all fallen out in the left temporal region. The decompressed area was bulging, but he had no headaches. His speech was about as it was when he was discharged from the hospital. When he reported for his last roentgen-ray treatment on April 4 his condition was much worse, and from that time his symptoms developed rapidly. He was taken to Philadelphia where he was operated on, and died April 28, 1922. Necropsy was not obtained.

Impression. The symptoms recurred during active roentgen therapy and rapidly caused the death of the patient. It is not evident that the treatment prolonged the life of this patient.

Case 15. Surg. No. 15726. *Spongioblastoma multiforme of right postcentral region. Osteoplastic extirpation. Roentgen therapy, T. 305. Secondary operation. Death two months later. No necropsy.*

N. H. W., aged sixty-one, was admitted Dec. 9, 1921, complaining of headaches, vomiting, and numbness and weakness of the left arm and leg, having been referred by Dr. Royal Hayes of Waterbury, Conn. She had been unusually well until the spring of 1921 when she began to have a dull ache over the right side of the head. In June she had a sensation of numbness and pricking in the left hand and in August her daughter noticed that this hand was awkward. In November the left leg became weak and awkward. About the middle of November vomiting occurred.

On examination there was found bilateral choked discs with an elevation of 1½ D., a left hemiparesis and hemihypesthesia, and a left homonymous hemianopsia. She became somnolent and stuporous in the hospital and on Dec. 12, 1921, Dr. Cushing turned down a bone flap over the right hemisphere. A large tumor was disclosed involving the parietal and postcentral area. A large mass of the tumor was removed, a subtemporal decompression was made, and the wound closed. Immediately following the operation the left hemiparesis was greatly exaggerated.

On Jan. 11 and 13 she was given roentgen treatments, 150 ma-min. each, 140 kv., 30 cm. distance, 0.5 mm. copper, without any apparent effect on her symptoms and on Jan. 15 she was discharged. She was able to walk but had a very marked left hemiparesis. The roentgen treatments were continued by Dr. Charles H. Brown of Waterbury, Conn., in all four roentgen treatments, on Feb. 10, Mar. 10, Apr. 28, and July 14, the technique consisting of 9 in. spark gap, 5 ma., 6 mm. aluminum filter,

distance 10 in., and time 14 min. each. Her condition remained practically stationary until August, 1922, when she began to complain of pain in the left side of the head. The left hemiparesis continued to progress.

She was re-admitted on Nov. 14, 1922, Surg. No. 17755, when it was found that the decompressed area was bulging; the hair in this region was completely gone as the result of roentgen treatments; there was a complete left hemiplegia, the upper limb being held contracted and flexed and the left lower extremity in rigid extension with the foot inverted and extended, and there was a bilateral secondary optic atrophy. On Nov. 20, 1922, Dr. Cushing re-explored the right hemisphere but was unable to find any surface indication of tumor. She recovered promptly and was discharged on Dec. 10, 1923, her condition unchanged. After discharge she became gradually comatose and on Feb. 14, 1924 she died. There was no necropsy.

Impression. The period of eight months between the operation and recurrence of pressure symptoms can probably be accounted for by the operative intervention. It is not clear that the roentgen treatment retarded the recurrence.

CASE 16. Surg. No. 18264. *Spongioblastoma multiforme of left inferior central region. Osteoplastic extirpation. Roentgen therapy, T. 494. Death seven months after operation. No necropsy.*

E. E. S., aged forty-six, was admitted Feb. 13, 1923, complaining of headaches, having been referred by Dr. M. L. Graves of Galveston, Texas. Seven weeks before admission he had a peculiar attack in which he was unable to speak for a few minutes. During this attack he was conscious of a very unpleasant odor. A week later he began to have frontal headaches and since then he has been unable to find names for objects.

On examination there was found a bilateral choked disc of 5 D. elevation, a right hemiparesis, and hemihypesthesia. There was some memory loss, inability to carry out calculations (his occupation being that of a civil engineer), and some difficulty in finding names for objects.

On Feb. 17, 1923, Dr. Cushing explored the left temporal region, without finding any evidence of tumor. A subtemporal decompression was made. He did not do well following the operation; developed a very marked aphasia, and became stuporous. On the 16th of March Dr. Cushing again explored the left hemisphere and a tumor mass about 3 cm. in diameter was removed from the region just above the Sylvian fissure and a little back of the foot of the central fissure. Following the operation he had a very marked aphasia. He understood very imperfectly what was said to him; was unable to read; his speech was limited to "yes" and "no," and he was unable to write. He was given roentgen-ray treatments March 1, 1923, 125 ma-min., and again March 31, 150 ma-min., technique "A," without any effect on his condition, and on April 2 he was discharged; his optic discs were still elevated 2 D.; there was a left facial paresis; his speech was still confined to "yes" and "no," but there was some improvement in his ability to understand. He was able to walk, but had a left hemiparesis and hemihypesthesia.

He continued to improve slowly in both his hemiparesis and his speech. He was given roentgen treatments in the Houston Clinic, Houston, Texas—in all a series of three treatments, May 12, 110 ma-min., June 23, 65 ma-min., and July 21, 1923, 120 ma-min., with 125 kv., 12 inch distance, 4 mm. aluminum filter. On June 3, 1923, he wrote that his hemiparesis had completely disappeared; his aphasia had practically disappeared, with the exception that he stuttered occasionally and sometimes could not find words. The right facial paresis which had been most marked was greatly improved; the decompression was less bulging. After the last roentgen treatment he grew rapidly much worse; the aphasia increased; he became unable to say anything except "yes" and "no;" his right arm became practically helpless and the operative site became tense and bulging.

He was re-admitted to the hospital on Aug. 30, 1923, Surg. No. 19569. At this time the decompressed area was bulging; there was a right facial paralysis; the left optic disc was elevated 3 D., there was a right hemihypesthesia and a right hemiparesis. The patient understood practically everything that was said to him, but was unable to carry out complicated orders. He had an almost complete anomia. It was not considered that an operation offered any chance of improvement and he was discharged on Sept. 6. He failed rapidly following discharge and died on Oct. 27, 1923. Necropsy was not obtained.

Impression. His early improvement seems definitely to have been due to roentgen therapy. The sudden decline after the last treatment may possibly be explained by hemorrhage or thrombosis of diseased vessels unfavorably influenced by the treatment.

CASE 17. Surg. No. 17165. *Spongioblastoma multiforme of left supramarginal region. Osteo-*

plastic operation with evacuation of cyst and partial extirpation of tumor. Roentgen therapy, T. 402. Secondary operation. Death. Necropsy.

C. A. P., aged forty-four, was admitted Aug. 15, 1922, complaining of pain in the right side of the head, difficulty in remembering words and hallucinations of smell, having been referred by Dr. S. Duerson Stout of Washington, D. C.

In June, 1922, he first noticed pain in the right temporal region. He had previously considered himself to be well, except that now he remembers that in 1916 he had an acute attack during which he was unable to understand what he read and was unable to express himself. He had practically recovered in five hours but some residual difficulty persisted for three weeks. Soon after the pain was noticed he began to have difficulty in finding words. In July he had several hallucinations of smell.

Examination disclosed bilateral choked discs of 4 D. elevation, an anomia, and a homonymous right lower quadrant defect in the visual fields.

On Aug. 19, 1922, Dr. Cushing turned down a large osteoplastic flap over the left temporal region. An immediate subtemporal decompression was made. The surface extension of a reddish tumor was disclosed in the supramarginal region. At a depth of 2 cm. in this region a cystic cavity was found which contained 30 c.c. of chocolate colored fluid. The surface tumor was outlined and removed.

The patient recovered promptly. His aphasic symptoms were not increased and he had no apraxia. He was discharged on Sept. 13, 1922, with his fundi subsided, headache relieved, and speech defect much improved. The notch in his visual fields persisted.

He was given a treatment with the roentgen ray before discharge on Sept. 5, of 150 ma-min., technique "A," and continued his own treatment, being himself a physician and roentgenologist. Six treatments were given Sept. 26, and Nov. 6, 1922, Aug. 17, 1923, Sept. 13, 1924, and June 13, 1925. The exposures were always given over the lesion, 5 ma., 0.25 mm. Cu, 1 mm. Al, 4 mm. leather, 30 cm. distance, 10 in. gap. The first four treatments were given for 30 minutes in one seance, but he found that the reaction was much lessened by dividing the dose, and this was done for the last two treatments, 15 minutes on succeeding days. The reaction following these treatments consisted of a feeling of nausea, an increase in the anomia, and slight erythema which persisted from two days to a week.

Under this treatment his condition remained practically stationary until June, 1925, when he was vaccinated because of an epidemic of smallpox which occurred in his city. When he was quite ill from the vaccination he began again to have headaches in the right temporal region, his anomia increased and the decompression became more tense and bulging.

On June 19 and 20 he had a roentgen-ray treatment which made him very nauseated and dizzy. He was re-admitted June 20, 1925, Surg. No. 24202. The decompression was bulging but soft. There was a right homonymous notch in the visual fields, somewhat larger than at previous admission. There was only slight anomia. He was discharged on June 30, 1925, to arrange his business affairs and return for operation, but did not return until Dec. 1, 1925, Surg. No. 25203. In the meantime his speech defect had increased and he was often nauseated and vomiting. The decompression was full and rather tense.

On Dec. 9, 1925, the older operative wound was reopened. The neoplastic tissue was adherent to the dura mater. Some fragments of the tumor were removed, opening a cystic cavity, but the growth was very vascular so that a radical extirpation could not be attempted.

He did very badly after the operation, ran an irregular temperature, and became stuporous. On Feb. 12, 1926, the wound was reopened and a large amount of vascular neoplastic tissue was removed. He did not rally from this intervention and died Feb. 17, 1926.

Necropsy revealed a badly lacerated extensive glioma of the left temporal lobe.

Impression. The long interval (thirty-two months) between the first operation and the necessity of re-intervention can only be attributed to the effect of roentgen therapy, for the tumor removed at the first operation was a typical spongioblastoma multiforme with numerous mitotic figures. We have reason to believe from the testimony of persons near him that he gave himself much more treatment than we have record of.

CASE 18. Surg. No. 19329. *Spongioblastoma multiforme of right postcentral region. Osteoplastic exploration with decompression. Roentgen therapy, T. 598. Secondary operation with extirpation. Death fifteen months from onset. No necropsy.*

E. C. K., aged forty-six, was admitted July 26, 1923, complaining of attacks of a prickling sensation in his left hand, having been referred by Dr. W. C. Harris of Yarmouth, Nova Scotia. He had been well until Feb. 13, 1923, when he felt a pricking sensation on the ulnar side of his left hand which spread up his arm. His arm was drawn away from his side and

then he dropped unconscious for perhaps half an hour. Six hours later he had a similar attack. During March and April he had minor attacks of pricking sensation in his left hand. Sometimes there would be a little twitching of his thumb. Five days previous to entry he had a more severe attack which lasted for half an hour and although he was not unconscious, his arm afterwards remained weak.

On admission there was found an inability to localize stimuli and a disturbance of position sense in the left hand, giving him an almost complete astereognosis. The strength of the muscles of the left hand was normal. His fundi were normal.

On Aug. 1, 1923, Dr. Cushing turned down a right bone flap disclosing a marked flattening of the convolutions posterior to the Rolandic fissure with a definite grayish patch in the posterior end of the incision. A small piece of this grayish tissue was removed and the wound was closed, after a decompression had been made in the temporal region. He was given a roentgen-ray treatment of 150 ma-min., technique "A," immediately after the operation, and the next day he had a series of epileptic attacks confined mainly to his left hand and face. By Aug. 4 he had developed an almost total paralysis of his left arm and a left facial weakness. He began to have a choked disc, and became incontinent of urine, very dull and apathetic. On Aug. 9 Dr. Cushing re-explored the right hemisphere thinking there must be a subdural hematoma; discovered no change in its appearance; removed the bone flap, and closed the wound. The patient continued to be very stuporous; his choked discs were elevated 1 D. It was only on Aug. 14 that he began to respond to questions. He was vomiting frequently. On Aug. 19 he had developed a practically complete left hemiplegia which had been gradually coming on since Aug. 8. On Aug. 28 his fundi were elevated 2–3 D.

On Sept. 7 Dr. Cushing re-explored the region, removing a large mass of tumor about 6 cm. in diameter. The patient was immediately improved following the operation and the next day he was talking and eating well. His left hemiplegia, however, was unchanged. He continued to improve and on Sept. 20 he was discharged, being mentally quite alert. The operative site was bulging only moderately and was soft; his optic discs had subsided; but there was no movement whatever in his left arm, though he was able to flex his knee and hip. He was given a second roentgen-ray treatment on Sept. 18, 1923, of 150 ma-min., technique "A."

On Jan. 15, 1924, his physician wrote that he was getting along well and was able to walk alone with the aid of a cane. He had had three similar roentgen-ray treatments by Dr. S. W. Williamson of Yarmouth, N. S., the last one three weeks previously. On this day he had a slight convulsive attack, the first one since the operation. March 26, 1924, he was having headache and was less well than he had been for some weeks. From this time he failed gradually; his legs became weak; he had difficulty in swallowing and attacks of vomiting, and gradually became comatose. On May 12 he died. The decompressed area, from which the bone flap had been removed, had increased gradually in size from the time of his discharge from the hospital.

Impression. After his discharge from the hospital roentgen therapy did not prevent a steady progress of the neoplasm. It is difficult to judge whether the operation or the roentgen treatment was responsible for the rapid progression of symptoms following the intervention of Aug. 1, 1923; probably both were in some measure to blame since the treatment was given at a time when any edema from the operation would be at its height.

CASE 19. Surg. No. 26147. *Spongioblastoma multiforme of left temporal lobe. Osteoplastic extirpation. Roentgen therapy, T. 1221. Death four months later. No necropsy.*

On April 13, 1926, Leroy L., aged forty-two, was admitted to the hospital, referred by Dr. N. R. Sylvester of Somerville, Mass., complaining of headache and vomiting.

In January, 1926, he fell in a generalized convulsion and was unconscious for twenty minutes. He had previously considered himself perfectly well. Since March he had had headache with occasional vomiting and about the same time there gradually developed a left hemiparesis.

He was drowsy and inattentive on admission. There were found bilateral choked discs of 3 D. elevation, and a left hemiparesis. The roentgen examination showed greatly increased vascularity in the right temporofrontal region.

On April 16, 1926, a right osteoplastic operation was done, disclosing a reddish tumor in the temporal region. It was thought to be a meningioma and its extirpation was deferred to a second stage, which was carried out on April 17, the patient having become very dull so that it was thought an extradural hematoma must have formed. A considerable portion of the tumor was removed. It proved to be a glioma of the type known as spongioblastoma multiforme.

The patient became much more alert follow-

ing this procedure but his hemiparesis was not improved. He was discharged on April 30, 1926. The decompressed area which had been made in the temporal region was bulging. The optic discs were not elevated and his headaches were relieved.

He had been given a roentgen-ray treatment on April 27 of 150 ma-min., technique "A," without any untoward results, and a second one on May 17, same dose.

On June 7 there was no choking of the optic discs and he was quite bright and co-operative, but the decompression was tense and bulging. There was a complete paralysis of the left arm and almost complete paralysis of left leg. Epilation was almost complete. Third roentgen-ray treatment was given on this day, same dose.

On June 28, decompression tense, left optic disc elevated 2 D., right disc flat. Hemiplegia unchanged. Epilation complete. Fourth treatment given, same factors.

On July 19 he was drowsy and disoriented. The optic discs were choked 2 D., and there was a complete left hemiplegia. Frequent vomiting spells and dizziness were present, and these symptoms were said by his wife to be worse on the day following each roentgen-ray treatment. The decompression was tense and bulging markedly. Fifth treatment given, same factors.

He died in August, 1926, at home, the exact date unknown. There was no necropsy.

Impression. The symptoms of this patient rapidly recurred and progressed during the course of roentgen treatment.

CASE 20. Surg. No. 21093. *Spongioblastoma multiforme of the left postcentral and temporal regions. Osteoplastic operation. Roentgen therapy, T. 772, with temporary improvement. Secondary operation. Death five months later. No necropsy.*

On April 5, 1924, Michael D., aged twenty-eight, was admitted to the hospital, referred by Dr. Fred B. Gunter of Chelsea, Mass., complaining of headache and failing vision.

He began to have headaches accompanied by vomiting in December of 1923. These had continued ever since with short periods of remission. Also in December, 1923, he had weakness of the right arm and leg. In March, 1924, he noticed that his vision was blurred, and lately there was some slight difficulty in finding words in speaking.

Examination disclosed bilateral choked discs of 5–6 D. elevation, right spastic hemiparesis and hemihypesthesia, and slight anomia. He was drowsy, apathetic and depressed.

On April 9, 1924, a left osteoplastic operation was done, disclosing the surface extension of a large glioma which seemed to underlie the postcentral and upper temporal regions. No attempt was made to remove it and the bone flap was taken off.

The aphasic symptoms were slightly increased after the operation for a few days and then the patient improved slowly. He was discharged on April 24, 1924. At that time his optic discs were elevated 1–2 D. The decompressed area was bulging but not tight. The hemiparesis was much improved. The headaches were relieved and he was feeling quite well.

He had been given a roentgen-ray treatment on April 16, with no untoward results. These treatments were continued, on May 7, May 28, June 18, July 9, and July 30, 1924, each 150 ma-min., technique "A." He improved slowly and was able to resume his duties as a clerk, writing all day long with his right hand.

In April, 1926, it was reported that the hemiparesis was increasing and some aphasia was present. He was also suffering from headache again. On May 13, 1926, he was readmitted, Surg. No. 26355.

The decompressed area was not full nor tight. There was a bilateral secondary optic atrophy without choking, a right spastic hemiparesis and hemihypesthesia, and very slight anomia.

On June 11, 1926, the old incision was reopened. The surface of the brain was of a grayish color, very hard and exceedingly tough and vascular. The margin of normal cerebral substance could not be determined so the wound was closed.

After the operation there was a marked aphasia which did not improve. He was discharged on June 29, 1926.

On July 17 he developed rather suddenly increased difficulty in speaking. He was given his seventh roentgen-ray treatment on July 22 without improvement.

He was last seen on Aug. 12, 1926. At this time he was completely hemiplegic with a marked aphasia. The decompressed area was bulging and tense, and the optic discs elevated 1–2 D. Eighth roentgen treatment was given this date.

He died on Nov. 22, 1926, having gradually become aphasic, incontinent and blind.

Impression. The interval of two years between operation and recurrence of pressure symptoms can be accounted for in part by the fact that the bone flap was removed, but it seems to us that this is not the entire explanation, for when re-admitted to the hospital the decompressed area was not bulging nor tense. The roentgen treatment seems really to have exercised a restraining influence upon the growth of the tumor.

The accident of July 17 was probably due to a hemorrhage into the neoplasm.

Case 21. Surg. No. 25230. *Spongioblastoma multiforme projecting into the third ventricle. Repeated surgical explorations without disclosing the lesion. Roentgen therapy, T. 1214, without improvement. Death. Necropsy.*

On Dec. 8, 1925, Philip S. T., aged twenty, was admitted to the hospital, referred by Dr. William R. Williams, of New York City, complaining of double vision and failing eyesight.

In May, 1925, he began to suffer from headaches, mainly in the frontal region but often suboccipital, and early in June vomiting began. It occurred without nausea and apparently without cause. Double vision was first noted on June 30. Late in July he felt tired and drowsy. From this time on he vomited rather frequently, but had little headache. On Nov. 3, 1925, a left frontal osteoplastic operation was done which disclosed only an internal hydrocephalus. His vision gradually failing, he was finally admitted to the hospital.

Examination showed the scar of the former exploration in the left frontal region, the bone flap being slightly elevated, weakness of the right external rectus muscle, occasional nystagmus, especially on looking to the left, slight right lower facial weakness, slight asynergy and hypotonicity of the right arm and leg, exaggerated tendon reflexes of both lower extremities, difficulty in standing in tandem position and bilateral choked discs of 4-5 D. elevation.

On Dec. 14, 1925, a suboccipital exploration was done without finding any lesion. He recovered promptly, nevertheless, and the choked discs subsided. He was discharged on Dec. 31, 1925, free from headache and vomiting. Asynergy, hypotonicity and unsteady gait were unchanged.

He continued well and gained weight but had periods when he would sit and gaze into space for hours, speaking in monosyllables only when directly addressed. He often wandered away and did not remember where he had been. His memory for recent events became very poor.

He was re-admitted to the hospital on March 26, 1926, Surg. No. 26046. He was alert and answered questions readily and accurately. There was a right hemiparesis with some asynergy. The optic discs showed no choking and the suboccipital decompression was not bulging, very slight nystagmus, especially on looking to the right.

A ventriculogram on March 29 showed a filling defect in the posterior part of the anterior horn of the left lateral ventricle. This procedure was followed by incontinence of urine for a few days, and a hyperthermia which subsided quickly. He was given a roentgen-ray treatment on April 5 in the left temporal area and April 6 in the right temporal area, each 150 ma-min., technique "A," and discharged on April 12, 1926, in about the same condition as on admission.

He was very restless at home; wanted to be always doing something, yet took no interest in anything, was morose and sometimes sullen. On April 15 he was incontinent of urine. On April 24 he was re-admitted. All of his symptoms were more marked. Whereas formerly he had been perfectly correct in his deportment now he was inclined to be profane in the presence of ladies. There was no choking of the optic discs. He was given a roentgen-ray treatment on April 26 in the left temporal region and April 27 in the right temporal area, dose as before, and discharged on April 28. After that he began to choke when attempting to swallow fluids. About May 5 he complained again of double vision and on May 14 had two attacks of vomiting. He was re-admitted on May 16, 1926, Surg. No. 26367. He was very sleepy, yawned frequently, and was very untidy. There was a bilateral ankle clonus but no Babinski sign on the left side, very slight nystagmus, right hemihypesthesia, right lower facial weakness, and spastic gait, especially of the right leg. He was given a third double roentgen-ray treatment on May 18 in the left temporal region and May 19 in the right temporal region, and discharged May 20.

He was re-admitted June 7, 1926, Surg. No. 26505. In the meanwhile he had grown steadily worse, was less responsive, tired easily, dragged his right foot and had attacks of hiccough. His neurological symptoms were about as on previous admission, but he was much more deteriorated mentally. A ventriculogram was done on June 8, which disclosed the fact that the third ventricle could not be filled with air in any position. This procedure was followed by hyperthermia, incontinence, and disorientation.

On June 18, 1926, a right transfrontal exploration was made, the frontal lobe elevated and an opening made into the third ventricle. An incision was then made in the dura along the median line, the frontal lobe retracted to the side, and the knee of the corpus callosum transected by blunt dissection, disclosing a dilated ventricle. (At necropsy it was found to be the right lateral ventricle.) No tumor was seen. The patient developed a hyperthermia, had periods of hyperpnea with opisthotonus and rigidity of the whole body and died the following day with a temperature of 107° F.

Necropsy. The brain was removed and fixed by immersion in formalin. A median sagittal section disclosed a tumor 5.5 × 3 cm. filling the third ventricle, except the infundibulum. It was attached only anteriorly along the columns of the fornix below the foramina of Monro.

Impression. It is not evident that roentgen treatment exercised any influence on the evolution of this tumor. Considering its situation it is remarkable that there was no severe reaction in the periods immediately following the treatment.

Case 22. Surg. No. 25113. *Spongioblastoma multiforme of left temporal lobe. Osteoplastic operation. Roentgen therapy, T. 1150. Death eight months later. No necropsy.*

On Nov. 4, 1925, Samuel M., aged forty-eight, was admitted to the hospital, referred by Dr. S. S. Katzman of Hartford, Conn., complaining of headache and failing vision.

In March, 1925, he began to have headache, mainly in the frontal region, his vision failed, especially in the left eye, and his friends noticed that he had difficulty in expressing himself. These symptoms slowly increased in severity, and since August there were also attacks lasting two to five minutes during which his right arm and leg trembled and became stiff, and he was unable to speak. There was no loss of consciousness during these attacks. There had been no vomiting.

The patient on admission was apathetic, and yawned frequently. There was found a right facial weakness, and marked aphasia, with alexia and agraphia. Spontaneous speech was fairly normal. The optic discs were choked 3–4 D.

On Nov. 9, 1925, a left osteoplastic operation was done, a subtemporal decompression made, and 40 c.c. of yellowish fluid was evacuated from a cyst of the temporal lobe. Large masses of neoplastic tissue were removed from the wall of the cyst. He recovered slowly and was discharged on Nov. 22, 1925. At this time he still had some anomia. The decompressed area was not bulging and only moderately tense. The optic discs were still elevated 1 or 2 D. He was given one roentgen-ray treatment on Nov. 20, of 150 ma-min., technique "A," without untoward results. On Dec. 12, Jan. 2, and Jan. 22 he was given treatments over the operative area, each a full dose as above.

On examination before treatment on Feb. 12, 1926, there was some fullness of the decompression which was only moderately tense. No aphasic symptoms were disclosed. He felt well, but the optic discs were elevated about 2 D. Epilation was complete. Treatments were continued on March 5, March 26 and April 16, 1926, each 150 ma-min., technique "A," at which time his decompression was quite soft. There was no swelling of the optic discs but some anomia, and weakness of the right facial nerve. He was feeling well and working steadily. Treatments were discontinued.

On Aug. 5, 1926, he returned, saying that he had been well until about Aug. 1 when he had a headache and the temporal region began to bulge. He began to use the wrong word when speaking. On examination it was found that the decompression was tense, the optic discs were elevated about 1 D., and there was a marked paraphasia and a right facial weakness. The right arm and leg were also weak with exaggerated tendon reflexes.

He did not return for further treatments, and died at home some time in July, 1927. No necropsy was obtained.

Impression. This tumor seems to have been retarded by the roentgen treatment when judged both by the clinical improvement and by the tenseness of the decompression until the acute accident of Aug. 1, 1926, which was probably a hemorrhage into the tumor.

Case 23. Surg. No. 24539. *Spongioblastoma multiforme of the left temporal lobe. Osteoplastic operation. Roentgen therapy, T. 1109. Death ten months after operation. Necropsy.*

On Aug. 10, 1925, Ralph C. H., aged forty, was admitted to the hospital, referred by Dr. Edward M. Taylor of Boston, Mass., complaining of headache, vomiting and failing vision.

He was well until July 15, 1925, when he began to have a dull headache in the frontal region which had persisted intermittently ever since, with occasional vomiting. For three weeks there had been some blurring of vision, some disturbance of speech, and his gait was unsteady.

Examination disclosed choked discs of 3–4 D. elevation, right facial weakness of central type, diminished right abdominal reflexes, and occasional anomia.

On Aug. 17, 1925, a ventriculogram showed displacement of the ventricles to the right and the left frontal horn was not filled. On Aug. 19, 1925, a left frontal osteoplastic exploration was done. An immediate subtemporal decompression was followed by the disclosure of the smooth surface of a highly vascular tumor occupying a large part of the temporal fossa which could not be removed because of excessive bleeding.

Following the intervention the patient was

irrational and disoriented at times, but his general condition was good. He was discharged on Sept. 13, 1925. At this time he was still having slight headache; the decompression was full and tense; the optic discs still elevated 1–2 D.; slight weakness of right arm and leg, and slight anomia and alexia.

He had a roentgen-ray treatment on Aug. 28, of 120 ma-min., technique "A," which resulted in a transitory increase in aphasia. He was incontinent for twenty-four hours, and the decompression became more tense. Treatments were continued with 150 ma-min. each on Sept. 18, Oct. 9, Oct. 30, Nov. 20, Dec. 11, and Feb. 3, at which time the decompression was full and tense, slight right facial weakness, optic discs choked 2–3 D. He was quite euphoric and had gained 40 pounds in weight. On Feb. 20 his wife reported that his aphasia had become suddenly much worse on Jan. 27. On Feb. 24 he was examined. There was a marked paraphasia, and almost complete anomia. Eighth roentgen treatment was given and the ninth on March 17, each 150 ma-min.

Last (tenth) treatment was given on April 7, 1926. He had been doing well until the last week of March, when he had a dizzy spell and fell. His aphasia was much worse after this accident. On April 7 he had an almost complete anomia and word deafness. The decompression was bulging. There was no elevation of the optic discs. From this time he failed rapidly and died at home on May 23, 1926. The brain was removed and sent to the hospital. There was a large glioma in the left temporal lobe extending inward to involve the basal ganglia (Fig. 4).

Impression. This patient had felt well under treatment until January 27, when his symptoms became suddenly worse. A similar accident occurred in March. It is most probable that these accidents were due to hemorrhage into the tumor.

CASE 24. Surg. No. 24243. *Spongioblastoma multiforme of the left temporal lobe. Osteoplastic operation. Roentgen therapy, T. 10-8. Secondary operation. Death two months later. No necropsy.*

On July 3, 1925, Morgan G. B. aged thirty-nine was admitted to the hospital, referred by Dr. E. W. Taylor of Boston, complaining of headache and failing memory.

On June 8, 1925, he had a severe headache and was somewhat confused. The headache had persisted since and was sometimes accompanied by vomiting. About a week after onset of the headache he began to have difficulty in remembering the details of his business transactions. He was inattentive, drowsy, yawned and rubbed his nose frequently.

He was inattentive and confused when examined on admission. There was a right lower facial palsy, and slight paraphasia and perseveration. There was only slight choking of the optic discs with no measurable elevation. He was given a roentgen-ray treatment on July 7, 150 ma-min., technique "A," 10 × 10 cm. area over the left supramarginal gyrus.

On July 8, 1925, a left osteoplastic exploration was made which disclosed a reddish gray tumor about 2 cm. under the surface of the temporal lobe. It was exposed by an incision

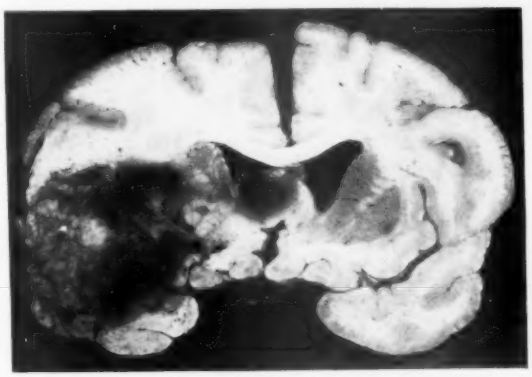

FIG. 4. Case 23. Spongioblastoma multiforme of the left cerebral hemisphere, extending into the basal ganglia.

through the superior temporal convolution and a mass about 5 cm. in diameter was removed. He did not recover well and on the following day the wound was reopened and a clot evacuated from the bed of the tumor. After this his recovery was without untoward incident. His decompression was soft and only slightly bulging. The aphasic symptoms almost completely disappeared but the left facial weakness persisted. He was discharged on July 27, 1925.

Roentgen-ray treatments were given over the left temporal region on July 27, Aug. 19, Sept. 10, Sept. 30, Oct. 21, and Nov. 11, 1925. None of these treatments was followed by any untoward symptoms.

After leaving the hospital he felt perfectly well and in November returned to his work and continued to do it satisfactorily until Jan. 10, 1926, when he felt weak and had a headache. On Jan 15 he had projectile vomiting and was conscious that he did not see well to the right side.

He was re-admitted to the hospital on Jan. 18, 1926, Surg. No. 25609. The subtemporal decompression was not bulging. There was a

right facial weakness of central type and slight weakness of the right hand, also a right homonymous defect of the visual fields. There was no choking of the optic discs. Very slight aphasic defects were possibly present.

On Jan. 28, 1926, the old incision was reopened and a large mass of recurrent tumor was removed from the temporal lobe. There was only one small cystic cavity. After the operation the patient continued to become slowly worse. The paresis of the right hand, the aphasia and the headaches progressed in spite of the eighth roentgen-ray treatment on Feb. 20, and he was discharged on March 7, 1926, with a right hemiplegia, very asphasic, decompression bulging and tense. He died at home March 23, 1926. There was no necropsy.

Impression. It cannot be considered certain that the roentgen treatment was favorably influencing this tumor for on Jan. 10, 1926, his improvement was terminated by an accident, probably once more a thrombotic or hemorrhagic lesion in the tumor.

Case 25. Surg. No. 24033. *Spongioblastoma multiforme of the right temporal lobe. Roentgen therapy, T. 1072. Secondary operation. Death three months later. No necropsy.*

On June 7, 1925, John W. C., aged forty-six, a merchant, was admitted to the hospital, referred by Dr. F. Nutter of Nashua, N. H., complaining of headache and vomiting.

In October, 1924, he had a severe headache accompanied by vomiting. Similar attacks recurred about once a month. Since May 1 headache was continuous, usually generalized but sometimes suboccipital. In the early part of May he was once blind for a few seconds and since then vision had been blurred. His memory became much impaired.

He was mentally very slow and co-operated in the examination with difficulty. There was found a left hemiparesis and hemihypesthesia, and slight choking of the optic discs without measurable elevation.

On June 13, 1925, a right osteoplastic operation was done. A subtemporal decompression was first made and a cyst of the temporal lobe was then evacuated. A nodule of tumor about 4 cm. in diameter was removed from its wall.

He recovered promptly and a roentgen-ray treatment was given on June 22, of 150 ma-min., technique "A," and he was discharged June 24, 1925. At this time he was euphoric and garrulous; the decompressed area was only slightly bulging and soft; the optic discs showed no choking, but the left hemiparesis and hemihypesthesia persisted.

He remained well about a week and then began again to suffer from headache and vomiting. His left arm and leg became much weaker; the decompressed area was tense and bulging; he became semicomatose and incontinent and was brought back to the hospital on July 7, 1925, Surg. No. 24262. On July 7, 1925, the old incision was reopened and a large amount of soft yellowish tumor was removed. No cystic cavity was found.

He recovered promptly and became again alert and garrulous. Choked discs (2 D. before operation) subsided. He was given a roentgen-ray treatment on July 13, and was discharged on July 16, with the decompression bulging slightly but soft; very slight paresis of left arm and leg, positive Babinski sign on left side, and headaches and vomiting entirely relieved. Roentgen treatments were repeated on Aug. 3, Aug. 25 and Sept. 15, each 150 ma-min., technique "A."

On Sept. 22, 1925, it was reported that he was again having daily headache. He was admitted to the hospital over night on Oct. 2, 1925, Surg. No. 24904. At this time the decompression was full and tense and there was a marked left facial weakness. Epilation was complete over the area treated with roentgen rays. He was given his sixth roentgen treatment on Oct. 3, and was discharged the following day.

He died at home on Oct. 24, 1925. There was no necropsy.

Impression. The symptoms in this case progressed steadily and seemed to be in no way influenced by roentgen treatment.

Case 26. Surg. No. 22406. *Spongioblastoma multiforme of the right frontal lobe. Subtemporal decompression. Osteoplastic operation. Roentgen therapy, T. 937. Death fourteen months after operation. Necropsy.*

On Oct. 10, 1924, David L., aged twenty-nine, a truck driver, was admitted to the hospital, referred by Dr. H. L. Rothblatt of Boston, and complaining of headache and vomiting.

About two months before admission he began to suffer from headache and vomiting. He was tired and drowsy at his work. Soon afterwards his vision became blurred. Two weeks after onset he fell unconscious in the street with an epileptic attack in which his left (?) arm and leg twitched. Lately the left side of the mouth drooped; he was irritable, excitable and tremulous; incontinent of urine; and staggered like a drunken man when walking.

He was drowsy and apathetic on examination. There was found anosmia of the left nostril, fine nystagmus, especially on looking

to the right, left facial weakness, left hemiparesis and hemihypesthesia, bilateral choked discs, staggering gait with tendency to fall to the left. It was impossible to make a satisfactory examination of the visual fields because of his apathy and inability to co-operate.

The cerebral ventricles were tapped on Oct. 20, and since only 2 c.c. were obtained from the right ventricle a right subtemporal decompression was done. There was some improvement in muscular power of the left side and of the mental condition, but the decompressed area soon became tense and bulging.

On Nov. 11, 1924, a right osteoplastic operation was done and a large cystic tumor found in the right frontal lobe. The cyst contained nearly 200 c.c. of yellow fluid. In its wall was a soft tumor, a large part of which was removed. Immediately following the operation he improved rapidly but soon he became dull and the bone flap protruded. On Nov. 20, 1924, it was necessary to reopen the wound and remove an extradural blood-clot. From that time on his condition remained satisfactory. The choked discs subsided; there was much less weakness of his left side; he was bright and co-operative. On Dec. 10, 1924, he was discharged.

Five roentgen treatments were given on Dec. 3, Dec. 24, 1924, and in 1925 on Jan. 14, Feb. 4, Feb. 25,—each 150 ma-min., technique "A." On March 18 and on April 21, 1925, the decompression was soft. There was no choking of the optic discs.

He returned to work and felt quite well until July 1, 1925, when he fell unconscious in the street, vomited, and was taken to a hospital. After that headache was almost constant. He lost his appetite and became very nervous. On July 21 he again suddenly lost consciousness and was brought to the hospital (Surg. No. 24381).

The next morning he was feeling well. The decompressed area was soft but bulging. There was some slight left facial weakness but no paresis of the arm and leg. He was very flippant, with an evident memory defect. No defect of the visual fields was found.

He was discharged on July 25, 1925, and given roentgen treatment on July 28, but he did not feel well, gradually lost his appetite and became drowsy. He had what he described as "weak spells" in which he would feel weak, break out in a cold sweat and vomit. Gradually the left side became weaker and finally on Aug. 15 he was no longer able to get about, complained of headache and was drowsy. He was re-admitted to the hospital on Aug. 20, 1925, Surg. No. 24621.

The decompressed area was tense and bulging. There was an outward squint of the right eye and ptosis of the right eyelid, left hemiparesis, bilateral secondary optic atrophy with slight swelling and practically complete blindness of right eye, apathy and drowsiness.

The cyst was punctured on several occasions, with temporary relief, and on Sept. 25, 1925, he was discharged. He returned to the Out-Patient Clinic, No. 100,272, to have the cyst tapped. He was also given his seventh roentgen treatment on Sept. 23, factors as before. In this way he did well until Oct. 13, when he began again to suffer from headaches. He was treated on Oct. 14, same dose. Finally on Oct. 26 he became comatose and was re-admitted, Surg. No. 25065. The cyst was evacuated with a lumbar puncture needle. He recovered consciousness at once and was discharged on Oct. 27. Ninth roentgen treatment was given on Nov. 4. On Nov. 7 and again on Nov. 21 the cyst was evacuated in the Out-Patient Department. Tenth roentgen treatment was given on Nov. 25. On Nov. 28 he was re-admitted, Surg. No. 25275, very dull, the decompression bulging and tense. On Dec. 10 the cyst was tapped; 50 c.c. of fluid was evacuated and the patient improved so much that he was again discharged without operation on Dec. 13.

He soon became comatose again; was incontinent; had generalized convulsions and was admitted for the last time on Dec. 22, 1925, Surg. No. 25433. At this time he was disoriented and semicomatose, with the decompression bulging and tense, and a left hemiparesis. The cyst was punctured but very little fluid was obtained; he remained semicomatose and had generalized convulsions, and finally died on Jan. 15, 1926.

A complete necropsy was done seven hours post mortem. There was found bronchopneumonia, and a large tumor, 5 cm. in diameter, in the right frontal lobe of the brain. It contained some small ragged cystic cavities and numerous hemorrhages. Microscopically it was of the type known as spongioblastoma multiforme.

Impression. It is difficult to judge the effect of the roentgen treatment in this case, complicated as it was by hemorrhages and cystic formation, and by frequent taps of the cyst to relieve the intracranial tension. It seems probable that there was some retardation of the growth but the treatment may also account in part for the numerous hemorrhagic accidents, which doubtless occurred, as for example, on July 1 and July 21, 1925.

Case 27. Surg. No. 24650. *Spongioblastoma multiforme of right frontal lobe. Osteoplastic*

operation. Roentgen therapy, T. 1118. Death from hemorrhage into tumor. Necropsy.

On Aug. 25, 1925, Haim H., aged forty-one, was admitted to the hospital, referred by Dr. Joseph H. Globus of New York City, complaining of headache, vomiting and failing vision.

He had been well until May, 1925, when he had an attack lasting only a few moments in which his head was drawn to the left side and there was a peculiar feeling of stiffness in the muscles of the neck. He felt a little faint and dizzy at this time. A month later a similar attack occurred. About the 1st of August he began to complain of dull headache in the frontal region and on Aug. 10 it was noted that he had a left facial weakness. Lately he had become silent, drowsy and made foolish irrelevant remarks.

On admission there were found bilateral choked discs of 2–3 D. elevation, a left hemiparesis, and marked mental dullness.

On Aug. 31, 1925, a right osteoplastic operation was done with a subtemporal decompression. In the posterior frontal region was found the surface extension of a large glioma. A mass about 5 or 6 cm. in diameter was removed.

There was a left hemiplegia following the operation which improved rapidly, but the decompressed area remained tense and the patient continued to be very dull. He was given one roentgen treatment on Sept. 11, 1925, of 150 ma-min., technique "A," with no apparent effect on his condition. He was discharged on Sept. 22, 1925. The headaches and vomiting were relieved; the optic discs were still elevated about 2 D., and there was a slight left hemiparesis.

He was given nine roentgen treatments from Oct. 2 to Oct. 22, 1925, by Dr. Maurice Lenz of New York City, through 4 portals of entry, crossfiring on the area of the tumor and using fractional doses of ⅓ to ½ skin unit dose, with a total dose of 3.5 skin units. The factors were 200 kv., 4 ma., 40 cm. distance, 0.5 mm. Cu and 0.5 mm. Al filter. One skin unit dose required forty-four minutes.

On Nov. 25, 1925, Dr. Globus reported that the left hemiparesis had improved, but that he had become more untidy and puerile. Shortly afterward he began again to have headache and vomiting and suddenly on Dec. 3 he became stuporous and five days later he died without regaining consciousness. Necropsy revealed an extensive spongioblastoma multiforme of the right frontal lobe in the posterior part of which was a "large hemorrhage invading the right lenticular nucleus."

Impression. There is no definite evidence that the roentgen treatment checked the evolution of this tumor and its course was terminated by a hemorrhage, as was proven at necropsy.

SUMMARY

The results of roentgen treatment of the spongioblastomas are much inferior to those obtained in the case of the medulloblastomas; still immediate improvement was obtained in Cases 13, 16 and 22. The long survival of Case 17 must also be ascribed to irradiation for the tumor was very rapidly growing, with two or three mitoses to each high power field of the microscope. It is probable that a recurrence was retarded in Case 20, possibly also in Case 26. The average length of life in these treated cases was only nineteen months from onset of symptoms.

On the contrary, Cases 14, 15, 19, 21, 23 and 25 progressed steadily under active treatment. A severe reaction followed the treatment of Case 13 on Oct. 15, 1921, and a still more disastrous result was occasioned in Case 18 by the treatment on Aug. 2.

Attention must be directed again to the sudden increase in symptoms which occurred in Cases 16, 20, 22, 23 and 24, and which we have interpreted as the result of thrombotic and hemorrhagic lesions in the tumor. This interpretation is supported by necropsy in Case 27. When one sees under the microscope the condition of the vessels in these growths the frequency of these accidents is not surprising. We have no comparative data by which to judge whether these accidents are more or less frequent in untreated cases but certainly roentgen treatment is not calculated to decrease their frequency.

The only tumors reported in the literature with sufficient data to allow one to identify them fairly certainly as spongioblastoma multiforme were Cases 1 and 3 of the report of Laruelle.[23] In both of them transitory improvement was obtained by means of radiotherapy.

C. ASTROCYTOMA PROTOPLASMATICUM

These tumors are soft and relatively avascular. They often contain cystic cavi-

ties whose origin seems to be different from those found in spongioblastoma multiforme. In the latter tumors the cavities seem to arise from necrosis secondary to thrombosis or hemorrhage, while in the astrocytomas the cystic spaces arise by a sort of liquefaction of the tissue, the blood vessels remaining fairly normal. The protoplasmic astrocytomas are slowly growing, but sometimes contain mitotic figures and numerous amitotic cellular divisions.

In several instances a typical protoplasmic astrocytoma has been removed at a primary operation, while at a secondary operation two or three years later the tumor removed from the same patient showed the typical structure of a spongioblastoma multiforme with numerous mitotic figures. It seems, therefore, that these tumors may dedifferentiate and become more malignant under certain circumstances not at present understood.

The average length of evolution of these tumors from onset of symptoms is over sixty-seven months.

Case 28. Surg. No. 13161. *Astrocytoma protoplasmaticum of the right postcentral region. Osteoplastic exploration. Roentgen therapy, T. 102. Secondary operation. Death twelve months after the second operation. No necropsy.*

J. P., aged forty-one, was admitted Sept. 14, 1920, complaining of headaches, convulsions, numbness of the left leg and blurring of vision, having been referred by Dr. G. H. Washburn of Boston, Mass. He had been perfectly well until 1904 when he began to have attacks consisting of a feeling of numbness in the left flank, spreading to the left leg and then the left wrist. These would last only two or three seconds. In February, 1920, he commenced to have mild headaches, especially in the morning on awakening. On March 15 he had a very sharp headache. About five minutes later his head twisted to the left and he lost consciousness. Since March he had had five attacks with loss of consciousness. They were always initiated by a feeling of numbness in the left side of the abdomen which spread into the left arm and leg; he was then unable to speak; about a minute afterward his head and face twisted to the left side, and he lost consciousness. After the attacks he slept and perspired freely.

On admission there was found bilateral choked discs with 2 D. swelling, a left hemihypesthesia and abdominal reflexes diminished on the left side.

On Sept. 18, 1920, Dr. Cushing turned down a large bone flap over the right postcentral region disclosing a large infiltrating glioma which seemd to involve the entire area exposed. A small cystic area containing 4–5 c.c. was found in the first temporal convolution. The bone flap was removed and the incision carefully closed. The patient recovered promptly with only some twitching of the left arm and forearm. He was given a roentgen-ray treatment on Sept. 23, 40 ma-min., 130 kv., 8 in. distance, through 7 mm. Al, to each of 2 areas, and was discharged on Oct. 8 with choked discs subsided and headaches relieved. Roentgen treatments were given June 8, over 4 areas, June 30, July 21, Aug. 11 (at which time complete epilation was noted), Nov. 21, 1921, and Jan. 3, 1922, each one large area as before, with 45 ma-min. the last two treatments.

On Jan. 10, 1922, when he was examined, the lower part of the decompressed area was bulging markedly, tense, tender to palpation and quite firm. He was complaining again of numbness in the left arm. This change had occurred following the last roentgen treatment. Three further roentgen-ray treatments were given Feb. 1, Feb. 8, one area each, and Mar. 3, 1922, to 2 areas. The treatment on Feb. 1, 1922, was changed to 150 ma-min., 140 kv., 12 in. distance, through 0.5 mm. Cu., and on Feb. 8, 150 ma-min., 140 kv. at 16 in. distance, through 6 mm. Al.

He was re-admitted to the hospital March 9, 1922, Surg. No. 16229, at which time his decompression had been bulging for about two and a half months. He was found to have bilateral choked discs of 4–5 D., a left hemihypesthesia with exaggeration of the deep reflexes on the left side and a marked hyperhydrosis of the left side. He was discharged on March 13 without treatment.

He was re-admitted March 23, 1922, Surg. No. 16310, complaining of very severe headaches. The decompressed area was very tense and bulging markedly; the choked discs had increased to 5–6 D., with hemorrhages; he had a paresis of the left lower extremity in addition to his previous symptoms. On March 24, 1922, Dr. Cushing made a typical subtemporal decompression incision and as soon as it was carried down to the cortex yellowish neoplastic tissue began to extrude. There was also a cyst containing 20 c.c. of yellowish fluid. A considerable mass of the tumor was scooped out, leaving a large cavity which was filled with salt solution. The wound was then closed. He made an excellent recovery. The choked discs promptly

subsided to 2 D. He was relieved from headaches and although his neurological findings were not changed, he was discharged on April 24, 1922.

He was re-admitted to the hospital on June 21, 1922, Surg. No. 16871. At that time he was having no headaches; his fundi showed secondary optic atrophy with no swelling; the hemihypesthesia had increased so that his left hand was almost anesthetic; there was some slight weakness of the left arm and leg; deep reflexes on the left side were increased with ankle clonus; abdominal and cremaster reflexes were absent on the left side. He was discharged the following day.

After his discharge the hernia gradually increased in size although headaches did not return. His left side became completely paralyzed, but he had no trouble with his speech and seemed to be in perfect possession of his mentality.

He died quite suddenly on the first of March, 1923, due apparently to some internal hemorrhage in the growth, for the hernia increased greatly in size and became quite hard and firm within a few hours. He had several convulsions, became rapidly unconscious and died. No necropsy was obtained.

Impression. The symptoms of this patient progressed slowly under active roentgen therapy, which was rather frequent but mild. The clinical evolution of the case was terminated abruptly, most probably by a hemorrhagic accident.

Case 29. Surg. No. 13851. *Astrocytoma protoplasmaticum, of the right central region. Osteoplastic extirpation. Roentgen therapy, T. 147. Death fourteen months after operation. No necropsy.*

L. F., aged forty-one, was admitted Jan. 15, 1921, complaining of weakness and twitching of the left hand, having been referred by Dr. W. M. Wolf, of San Antonio, Texas. Since 1901 he had had headaches almost every day. In 1914 they became much worse and would start on awakening in the morning, gradually become more severe at about 4 P.M., and he would go to bed with a very severe headache. On Nov. 28, 1920, he had an attack of twitching of the left hand, arm and leg which lasted about five minutes, during which he did not lose consciousness. Following the attack there was a sensation of numbness on the entire left side of the body. Since then he has had four similar attacks, the last one Jan. 12, 1921. The attacks began with twitching of the left thumb.

On examination there was found very slight haziness of the nasal margins of both optic discs; there was a paresis of the left upper extremity more marked in the small muscles of the fingers; there was a left facial weakness of central type; all of the tendon reflexes on the left side were slightly exaggerated.

On Jan. 21, 1921, Dr. Cushing turned down a right osteoplastic flap and exposed a tumor of the brain substance in the mid-Rolandic area, somewhat triangular in shape and measuring perhaps 2.5 cm. on each side. This area was blocked out and removed to a depth of about 3 cm., although it was obvious that not all of the growth was removed.

Following the operation he had a paralysis of the left arm and the left facial paresis was increased. He had twitching attacks of his left shoulder and face. There was a paresis of the left lower extremity also. He gradually recovered the use of his left side and on Feb. 3 was able to move his left arm. He was given a roentgen treatment on Jan. 31, of 40 ma-min., 132 kv., 8 inch distance, through 6 mm. Al, without any apparent effect on his symptoms. He was discharged on Feb. 19, 1921, at which time he was walking with the aid of a cane; had some movement in his left arm; his facial paralysis had disappeared; deep reflexes were hyperactive on the left side. On Aug. 2, 1921, his wife wrote that he had had eight roentgen treatments of short duration and lightly filtered, by Dr. W. S. Hamilton of San Antonio, apparently without any effect on his condition, which remained practically stationary. On Aug. 31, 1921, he began to have severe left-sided convulsive attacks. In September his wife wrote that he was having severe headaches. His left-sided weakness rapidly increased and he died in October, 1921.

Impression. Mild roentgen therapy did not influence this patient's condition and did not prevent a rapid recurrence of symptoms which led to his death.

Case 30. Surg. No. 14204. *Astrocytoma protoplasmaticum of the cerebellum. Suboccipital exploration with evacuation of cyst. Secondary operation eight months later with partial extirpation of solid tumor. Roentgen therapy, T. 297. Apparently well in April, 1925.*

F. E. T., aged fourteen, was admitted March 18, 1921, complaining of headache, dizziness and vomiting, having been referred by Dr. J. J. Duggan of Milford, Mass. In September, 1920, he began to have generalized severe headaches, having been well up to that time. The headaches were associated with vomiting. He had been rather drowsy, and his gait unsteady.

On admission there was found a cracked-pot

sound on percussion of the head, slight nystagmus on looking to the right and left, slightly unsteady gait, bilateral choked discs of 1–2 D., suboccipital tenderness; in short, symptoms of internal hydrocephalus, with very slight signs of cerebellar disturbance.

On March 29, 1921, Dr. Cushing did a suboccipital exploration, disclosing a cyst at a depth of 3 cm. which contained possibly 10 c.c. of yellow clotting fluid. The patient recovered promptly and was discharged on April 17, 1921; his gait was quite normal; there was very slight incoördination of his right arm; the fundi had subsided; the headaches and dizziness were relieved. On Sept. 15, 1921, his physician wrote that the patient's suboccipital region was bulging; he was vomiting; staggered in walking and complained of double vision.

On Nov. 12, 1921 he was re-admitted to the hospital, Surg. No. 15563. At this time there was a very marked bulging of the suboccipital region but no measurable elevation of the optic discs. His gait was slightly unsteady, but there was no incoördination of the extremities. On Nov. 18, 1921, Dr. Cushing re-explored the suboccipital region, disclosing a recurrent solid tumor, a great portion of which was scooped out, reducing the tension sufficiently to close the wound. No cystic cavities were found. He made a prompt recovery; his headaches were completely relieved. He was given roentgen treatment Dec. 7, 1921, to the left half of the cerebellum and Dec. 8, 1921, to the right half, and was discharged on Dec. 8, with his gait normal, no nystagmus, no incoördination of the extremities, in every way free from symptoms. Roentgen treatments were given Dec. 20, 1921, right cerebellar; Dec. 27, left cerebellar; Jan. 17, 1922, left cerebellar and Feb. 7, 1922, left cerebellar, each treatment 150 ma-min., 140 kv., 12 in. distance, through 0.5 mm. copper. Epilation was noted Jan. 17, 1922. No erythema was obtained.

He continued to do well until June 15, 1922, when he began again to have headaches and nausea from which he spontaneously recovered; however, and on the 23d of November, 1923, he wrote that he was in perfect health. On April 23, 1925, he was in perfect health, had just passed an examination to be admitted to the Massachusetts Nautical School and was apparently quite recovered. He was examined on March 12, 1925. The suboccipital region was bulging and somewhat tense. There was moderate ataxia and dysmetria. The optic discs were blurred but there was no measurable elevation.

Impression. Rapid recurrence of symptoms after the first operation and long improvement after the second operation might be interpreted as due to roentgen treatment. But it must not be forgotten that the tumor was not removed at the first operation. Furthermore, it is not certain that irradiation has prolonged the life of this patient for there are just as favorable records in the clinic of patients not submitted to irradiation after operation for astrocytoma protoplasmaticum.

Case 31. Surg. No. 14550. *Astrocytoma protoplasmaticum of the left temporal and inferior parietal region. Osteoplastic exploration with evacuation of cyst. Roentgen therapy, T. 224. Death thirty-four months after operation. No necropsy.*

E. E. T., aged fifty, was admitted May 18, 1921, complaining of dizziness, headache, vomiting and failing vision, having been referred by Dr. Frank Jackson of Houlton, Maine. On July, 1918, vomiting became persistent. He was unsteady on his feet and reeled like a drunken man in walking. In 1919, he was comparatively free from headaches and vomiting, but he complained that he could not read well because of blurring of the letters. In September, 1920, the headaches returned accompanied by vomiting. In January, 1921, his gait became so unsteady that he was obliged to give up walking. Since January, 1921, he had become forgetful, untidy and semistuporous.

On admission to the hospital he was found to have bilateral choked discs of 2 D., staggering gait, exaggeration of the deep reflexes on the left side with clonus at the ankle and with a very marked memory loss. He was disoriented, unco-operative and untidy. There was very evident anomia and agraphia. He had also a right homonymous hemianopsia.

On May 25, 1921, Dr. Cushing explored the left hemisphere and found a huge surface glioma extending downward into the temporal lobe and posteriorly as far as could be seen, containing a cyst from which about 30 c.c. of fluid was withdrawn. This cyst lay 4 cm. under the surface. A fragment of tissue was removed for examination, a subtemporal decompression made, and the wound closed. He recovered promptly; was much brighter mentally, and took a greater interest in his surroundings. His memory was still poor but his anomia improved to a certain extent. He was given roentgen-ray treatment on June 20, 1921, 160 ma-min., 132 kv., 15 inch distance, through

0.5 mm. copper. On June 21 he was discharged, able to walk alone, with little unsteadiness, disoriented concerning time and persons; able to write his name, but still unable to do mathematical calculations. His optic discs were still elevated 1 D; he was free from headaches, and quite comfortable. Roentgen treatments were continued on July 13, 120 ma-min.; Aug. 4, 130 ma-min., and Aug. 25, 1921, 100 ma-min. at 12 in. distance to each of 2 areas. On Nov. 21, 1921, his physician wrote that he was able to go hunting and to do a great deal of work about the farm. He had no headaches. His mental condition had also greatly improved.

On June 25, 1923, his physician wrote that the decompressed area had become enlarged; was gradually increasing in size; but he still suffered no pain, and was able to go about as he pleased. On Dec. 14, 1923, it was reported that he had begun to have headaches again, which gradually increased; his mental condition became worse, and on March 1, 1924, he died. Necropsy was not obtained.

Impression. Improvement occurred after operation and during roentgen treatment. It is difficult to apportion justly the credit due each method of treatment. At any rate, the long freedom from symptoms was not necessarily caused by the roentgen treatment.

CASE 32. Surg. No. 14914. *Astrocytoma protoplasmaticum of the right temporal lobe. Right subtemporal decompression. Roentgen therapy, T. 258. Osteoplastic extirpation. Death six months later. No necropsy.*

I. H. B., aged forty-one, was admitted on July 25, 1921, complaining of headache, nausea and vomiting, having been referred by Dr. Louis Ladd of Cleveland, Ohio. He had been healthy and active until March, 1921, when he noticed what he called "sinking spells," followed by a peculiar but not unpleasant odor. Sometimes he had these attacks 6–8 times a day. On July 1, 1921, he began to have headaches and on July 10 he vomited for the first time. He became disoriented and irritable. Lately during the attacks he had noticed that the right arm and leg would twitch and feel as though asleep, then perspire profusely.

On examination he was found to have a very early bilateral choking of the optic discs but there were no localizing symptoms.

On July 29, 1921, Dr. Cushing did a right subtemporal decompression for, although the tumor was known to be in the temporal region, it could not be determined whether it was right or left. He recovered promptly from this; the choked discs subsided; but he continued to have the attacks. He was discharged on Aug. 12, 1921.

He was re-admitted Sept. 20, 1921, Surg. No. 15225. He had remained practically in the same condition until Sept. 8, 1921, when he noticed for the first time that the decompressed area was tense and somewhat bulging. The same day he began to have headaches. On Sept. 11 he vomited for the first time since operation. The headaches and vomiting had continued until his admission, when it was found that his discs were choked 1 D. The decompression was bulging and tense; there was a left homonymous upper quadrant defect in the visual fields. Roentgen-ray treatments were given Sept. 20, and Oct. 7, 1921, to the right temporal area, the first with 50 ma-min., 132 kv., 10 in. distance, through 6 mm. Al; the second 200 ma-min., 132 kv., 12 in. distance, and 0.5 mm. copper. He was discharged on Oct. 13, 1921, to continue roentgen therapy. He was re-admitted Oct. 24, 1921, Surg. No. 15441. He was having no headaches and no vomiting. The decompression was soft and spongy; his optic fundi were clear, although the nasal margins were still indistinct. He was still having sinking spells every day but had been leading a very active physical life. A roentgen treatment was given on Oct. 24, 150 ma-min., 12 in. distance, 0.5 mm. Al, and he was discharged on Oct. 26. Epilation was present but no erythema. Roentgen-ray treatments were continued by Drs. Hill and Thomas of Cleveland, Ohio, Nov. 16, 1921 and Dec. 7, 1921 with 48 ma-min., 120 kv., 10 in. distance, through 0.25 Cu and 3 mm. Al, the first time; 75 ma-min. the second time.

In December, 1921, he began again to have severe headaches and vomiting. Headaches became very severe and his vision became blurred following the last roentgen-ray treatment. He became semi-stuporous and complained of visual hallucinations and was returned to the hospital on Dec. 17, 1921, Surg. No. 15772, at which time the decompressed area was bulging and tense; there were bilateral choked discs of 3 D., and a left hemiparesis. On Dec. 19, 1921, Dr. Cushing turned down a right bone flap and a tumor mass about 4 × 5 cm. in diameter was extirpated from the temporal lobe. It was evident that the tumor was far more extensive than the opening, so the bone flap was stripped off and the skin incision closed. The patient recovered slowly and was discharged Jan. 25, 1922, with the decompressed area bulging and a complete left hemiplegia, although he was quite bright mentally. On April 4, 1922, his physician wrote that he was much improved, although he still had a complete left hemiplegia. He was not suffering

from headaches although he complained of pain in his left side. About April 27, 1922, he began to fail and on May 2, 1922, he died.

Impression. This patient's lesion after temporary improvement progressed steadily under roentgen therapy; his symptoms were definitely exaggerated by the last treatment.

Case 33. Surg. No. 15308. *Astrocytoma protoplasmaticum of the cerebellum. Suboccipital exploration. Roentgen therapy, T. 282. Secondary operation with extirpation. Apparently well in March, 1927.*

W. L. D. C., aged nine, was admitted Oct. 3, 1921, complaining of headache, vomiting and dizziness, having been referred by Dr. A. Greenwood of Boston, Mass. He had begun to be dizzy in the summer of 1920. During the spring of 1921 he again had dizzy attacks and in the middle of May, 1921, he began to have suboccipital headaches accompanied by vomiting. For about a month he had held his head tilted to the left. His vision had been diminishing rapidly during the last month until on admission he could only distinguish light and shadow.

Examination showed a bilateral secondary optic atrophy with very slight swelling of the optic discs, cracked-pot sound on percussion of the skull, nystagmus on looking to the right, suboccipital tenderness, stiffness of the neck, staggering gait and incoördination of all the extremities of cerebellar type. At times he had no nystagmus whatever. The incoördination of his extremities was very slight.

On Oct. 14, 1921, Dr. Cushing did a suboccipital operation disclosing a soft rounded mass of tumor in the posterior portion of the vermis extending down into the spinal canal. The lower pole of the growth was removed. The patient recovered well from the operation and was discharged on May 6. His fundi had subsided; the headaches were relieved; his gait was quite steady, and his general condition excellent.

He was given roentgen-ray treatments on Nov. 4, 175 ma-min., Nov. 21, and Dec. 5, 1921, 225 ma-min., and Jan. 24, 1922 and Mar. 13, 1922, 175 ma-min., each with 140 kv., 12 in. distance, through 0.5 mm. Cu. He gained in weight and although his vision did not improve, he was free from symptoms until the latter part of November, 1924, when he began again to have headaches and for the last three weeks they had been very severe. On March 18, 1925, he had an attack of severe headache with vomiting and was admitted to the hospital on March 19, 1925, Surg. No. 23466. At that time it was found that there was an enlargement of the head with cracked pot sound on percussion, bilateral secondary optic atrophy, nystagmus on looking to the right and left, unsteady gait, hypotonicity and slight incoördination of the extremities. On March 20 he had a severe headache and vomiting. On March 27, 1927, 50 per cent of a full dose, technique "A," was given which caused nausea and vomiting. On April 1, 1925, a 40 per cent dose was given, with the same result.

On April 10, 1925, Dr. Cushing re-exposed the suboccipital region and discovered a tough mass of neoplastic tissue in the central and intermediate portion of the cerebellum which contained a cyst from which 15 c.c. of yellow clotting fluid was removed. Subsequently 3 or 4 smaller cysts were encountered. Evacuation of these cysts caused the tumor partly to collapse so that it was possible to separate the main mass weighing 32.5 gm. from the central portion of the cerebellum and to remove it. Its removal allowed one to look directly into the cavity of the 4th ventricle. The patient had a very marked postoperative hyperthermia which gradually subsided. He had also a polyuria which reached 3,500 c.c. on the 5th postoperative day and then gradually subsided. He recovered slowly and was discharged on May 11, 1925. At that time he was somewhat apathetic; preferred to lie in bed, and slept most of the day. He was able to walk without assistance. His nystagmus persisted. He had no headaches or vomiting and no complaints of any kind. The most extraordinary fact was the change in his mentality since the operation. Whereas before he was laughing and joking with the other patients in the ward, since the operation he was drowsy and very much of a retiring disposition. He was not given any further roentgen-ray treatments.

March 30, 1925. Report from the Perkins Institution for the Blind: "He is strong and active and is growing tall."

Impression. It is not certain that irradiation had any effect upon this patient's condition. He was treated in 1925 shortly after the incident recorded in Case 4. It was for this reason that his dosage was divided. A full dose would probably have had the same result as in Case 4.

Case 34. Surg. No. 15578. *Astrocytoma protoplasmaticum of the cerebellum. Suboccipital exploration with evacuation of cyst. Roentgen therapy, T. 753. Secondary operation twenty-eight months later. Apparently well in April, 1925.*

J. H. N., aged seventeen, was admitted Nov. 15, 1921, complaining of headache and dizziness, having been referred by Dr. F. C. Brigham of Springfield, Mass. For three months he had had pains in the head. For six weeks these had been accompanied by vomiting. For four weeks he had stopped working because he was too dizzy. For the last two weeks he had been in bed.

On examination there were found a few slight nystagmoid movements on looking to right and left, marked unsteadiness of gait, incoördination of cerebellar type, and hypotonicity involving particularly the left upper extremity.

On Nov. 25, 1921, Dr. Cushing did a suboccipital exploration and a needle inserted into the left cerebellar hemisphere struck a large cyst at a depth of 4 cm., from which 70 c.c. of yellow fluid was removed. The cyst was opened and its interior thoroughly fixed with Zenker's fluid. He recovered promptly and was discharged on Dec. 17, 1921. His headaches were relieved; his gait normal; fundi subsided to about 1 D.; this incoördination of his left arm had disappeared. He remained quite well until March 5, 1924, when he began again to complain of dizziness, staggering gait and double vision, and was re-admitted to the hospital on March 20, 1924, Surg. No. 20963.

On examination it was found that he had a sustained nystagmus on looking to the right and left, bilateral secondary optic atrophy, dysarthria and staggering gait. He was given roentgen-ray treatments of 150 ma-min. each on March 21 and 22, crossfiring on the cerebellum, without any effect upon his condition.

On March 31, 1924, Dr. Cushing re-explored the suboccipital region. Although the cerebellum was punctured in many directions no cyst was found. The cerebellum itself, however, presented a curious appearance as though it were infiltrated with neoplastic tissue; a portion was removed for histological examination, and the wound closed. Roentgen-ray treatment was given on April 16, 1924, 162 ma-min., technique "A."

He was discharged on May 3, 1924, with his symptoms unchanged. He improved slightly on his return home and on April 25, 1925, his condition seemed to be practically unchanged.

Impression. In this case, roentgen therapy was ineffective and the second operation likewise accomplished nothing. Nevertheless he continues to remain well.

CASE 35. Surg. No. 16820. *Astrocytoma protoplasmaticum of the medial surface of the right frontal lobe. Right subtemporal decompression. Ventriculogram. Osteoplastic extirpation. Roentgen therapy, T. 573. Gradual progression of symptoms. Death. No necropsy.*

E. V. R., aged forty-three, was admitted June 15, 1922, complaining of headaches and fainting, having been referred by Dr. F. A. Clegg of Lawrence, Mass. She had been well until August, 1921, when she began to have occasional headaches in the occipital region, radiating to the front. Three months before admission she had some spells of unconsciousness, lasting a few minutes, without muscular twitchings. Her memory had recently been failing.

On examination there was found to be bilateral choked discs of 2 D., and nystagmus on looking to the right and left. On June 15 she had some slight dysarthria, incoördination of the extremities of cerebellar type, persistent nystagmus on looking to the right and left. On June 16, Dr. Horrax attempted to puncture the right ventricle but could obtain no fluid. On June 21 he did a right subtemporal decompression. The brain was under considerable tension. The ventricle could not be located. She recovered promptly, her headaches being relieved. She was discharged on July 1 when the fundi had subsided; there were no headaches or discomforts; there was slight bulging of the decompressed area.

She was re-admitted March 28, 1923, Surg. No. 18515, having in the meantime become quite unsteady in walking, with some vomiting and headache. At that time it was found that she had bilateral secondary optic atrophy, left facial paresis, left hemiparesis, a hemiplegic gait, exaggeration of the deep reflexes on the left, clonus of the left ankle and astereognosis of the left hand.

On April 3, 1923, Dr. Horrax did a right cerebral exploration and found a dilated ventricle. Air was injected into the ventricle which showed a pressure defect at the upper portion of the right anterior horn. The findings were thought to indicate a tumor of the median portion of the right hemisphere, and on April 20, 1923, Dr. Cushing re-elevated the bone flap but no tumor was found. May 11, 1923, Dr. Cushing did another ventriculogram which showed a concave defect of the upper edge of both lateral ventricles suggesting a tumor pressing down on the corpus callosum.

On June 8 Dr. Cushing re-elevated the old bone flap and at the upper edge of the flap disclosed what appeared to be an endothelioma. The bone flap was stripped off and on June 13, 1923, Dr. Cushing enucleated a large frontal glioma about 6 cm. in diameter. Following this the patient's mental attitude improved remarkably; she become quite bright and happy; her fundi subsided, but the left side

remained paralyzed. Roentgen-ray treatments were given on June 29 and July 19, each 150 ma-min., technique "A."

She was discharged on July 21 and remained well for eight or nine months during which time roentgen treatments were given Aug. 9, Aug. 30, Sept. 20, and Nov. 8, 1923, each 150 ma-min., technique "A." In the autumn of 1924 she became disoriented, and for two or three months had bad headaches and attacks of vomiting. The herniation of the area from which the flap had been removed had increased and she was re-admitted on Jan. 26, 1925, Surg. No. 23086, at which time it was found that she had a left-sided spastic hemiplegia, very marked memory loss and disorientation. The decompressed area was tense and bulging. It was not thought that surgical measures would help her condition and she was discharged on Feb. 9, 1925. A treatment of 120 ma-min. was given on Feb. 3, without any effect. She died at home on March 16, 1925. There was no necropsy.

Impression. The period of freedom from pressure symptoms, June 13, 1923, to September, 1924, can be accounted for by removal of the tumor. It is not apparent that the roentgen therapy increased the length of this period.

CASE 36. Surg. No. 19942. *Astrocytoma protoplasmaticum of the right occipito-temporal region. Osteoplastic exploration and decompression. Secondary extirpation in two stages. Roentgen therapy, T. 581. Death ten months after extirpation. No necropsy.*

C. T., aged forty-six, was admitted in coma June 14, 1923, having been referred by Dr. W. S. Quigley of Charlestown, Mass. He had been well until seven months previous to admission when he began to complain of slight headache in the frontal and occipital regions. A month later he had a generalized convulsion following which he was unconscious for six hours. Headaches then became much worse. His gait was unsteady. Three months before admission he had a second convulsion and was unconscious for half an hour. For two weeks he had been vomiting. The day before admission he complained of very severe headache and rapidly became comatose.

On admission to the hospital he was quite comatose, having marked Cheyne-Stokes respiration. There was a left facial weakness, absence of the left abdominal reflexes and of the left corneal reflex. He moved his left leg much less readily than the right. There was a positive Babinski sign and ankle clonus on the left side. He was given hypertonic saline intravenously. He was admitted at 3:30 P.M. and at 5:30 P.M. Dr. Bailey turned down a bone flap over the right hemisphere. No tumor was found in the area exposed, so a generous subtemporal decompression was made; the flap was replaced and the wound closed. The patient recovered slowly and by June 19, although sometimes irrational, his general condition had improved greatly. The left hemiparesis persisted and it was obvious that he had also a left hemihypesthesia. On June 23 Dr. Cushing re-elevated the bone flap. The opening was enlarged posteriorly in the lower part of the field and a fairly firm tumor was disclosed in this region. There was no definite boundary and it was evident that in order to get a better view a much more thorough operation would have to be carried out. Consequently a specimen was taken for histological examination and the wound closed. This operation was done under local anesthesia, as indeed was also the first, and although he developed some delusions of persecution and was quite unruly for a few days, his condition was otherwise unchanged. On July 9 he was up and walking about the ward; his discs were still elevated 1 D., he had a slight left facial weakness and a slight hemiparesis. His decompressed area was bulging markedly. On July 9, 1923, Dr. Cushing under local anesthesia made an incision over the lower posterior angle of the old flap backward toward the occiput, disclosing a massive tumor which contained a few cysts but had no definite outline. A great amount of this tumor was spooned out; the bleeding was checked and the wound closed. He was given a roentgen-ray treatment of 120 ma-min., technique "A," immediately following the operation. This operation being done under local anesthesia did not seem to disturb the patient in the least. He remained bright and well oriented and was discharged on July 1, 1923. There was still some slight facial weakness, and weakness of the left arm. There was no longer any ankle clonus or Babinski sign on the left side. His optic discs were quite flat. He came in for roentgen treatments on July 30, 150 ma-min., Aug. 20, Sept. 11, Oct. 9, each 162 ma-min., and Oct. 29, 1923, 150 ma-min., all technique "A," and was quite well although occasionally irritable and unruly until about eight weeks before his death when he began again to develop paralysis of the left side. A seventh roentgen-ray treatment was given on April 14, 1924. From that time on he failed rapidly, was unable to come for further treatments, and died on May 29, 1924.

Impression. The roentgen treatment did not influence the recurrence of this

patient's symptoms, and probably did not prolong his period of freedom after operation.

CASE 37. Surg. No. 19116. *Astrocytoma protoplasmaticum of the left postcentral region. Osteoplastic exploration. Roentgen therapy, T. 584. Temporary improvement followed by failure and death. No necropsy.*

C. C., aged fifty-eight, was admitted June 26, 1923, complaining of attacks of prickly sensation in the right hand, having been referred by Dr. A. W. Goodall of Boston, Mass. She had always been well, except that for four or five years she had had attacks of pricking sensation in the right hand, lasting for five to ten minutes, during which the hand became numb. After a year or so the hand seemed to be always numb and she had difficulty in picking up small objects. About a year before admission she began to have twitching of the right hand accompanying the sensory attacks. A few months before admission her face also was involved in these attacks. At the time of admission the attacks occurred practically every day, sometimes accompanied by loss of consciousness and vomiting. She had had only slight headaches in the frontal region accompanying the more severe seizures.

On examination it was found that there was some haziness of the upper nasal margins of the optic discs, but no measurable elevation. Tendon reflexes of the right arm were exaggerated. There was muscular weakness, especially of the small muscles of the right hand, and a hemihypesthesia of the right half of the body to pinprick, light touch and cold. The patient had several typical attacks in the hospital and on July 6, 1923, a bone flap was turned down by Dr. Cushing over the right postcentral region. The area posterior to the Rolandic fissure was pale, soft on palpation and protruded more than the anterior field. A specimen was removed from this region and was found to be a protoplasmic astrocytoma with no evidence of normal cortical tissue. No decompression was left.

Following the operation she had some twitching attacks of the right arm as on July 9. She recovered very promptly from the general effects of the operation; was given a roentgen-ray treatment on July 16 of 150 ma-min., technique "A," and discharged on July 20. Her neurological symptoms were unchanged. Roentgen-ray treatments were continued on Aug 6, Aug. 27, Sept. 17, and Oct. 8, 1923, each the same dose. She was next seen on March 25, 1925. She was feeling well and doing her own housework. Her symptoms had improved, for the strength of the right hand was perfectly normal, and no trace of the hemihypesthesia could be found. She was not having attacks but since she was under heavy doses of luminal, it is perhaps not surprising.

Examined again on Nov. 3, 1926, she was quite well, doing all her housework and had only occasionally slight attacks of pins and needles in the right hand with twitching of the right side of the face.

On Feb. 25, 1927, her physician reported that she had developed slight aphasia and was mentally confused. There was also a paresis of the right arm.

She improved a little in March but in April failed rapidly and died May 5, 1927. There was no necropsy.

Impression. Roentgen therapy was most likely responsible for the disappearance of this patient's neurological signs.

CASE 38. Surg. No. 19383. *Astrocytoma protoplasmaticum of the cerebellum. Suboccipital decompression. Roentgen therapy, T. 618. Secondary operation with extirpation of tumor. Death three months later. No necropsy.*

C. W. K., aged thirteen, was admitted Aug. 5, 1923, complaining of headache and vomiting, having been referred by Dr. Chas. M. Stearns of Chelsea, Mass. He had been well until six weeks previous to admission, when he began having a frontal headache. For the last two or three weeks he had had projectile vomiting. The day before admission he was drowsy and semiconscious.

On admission there was found bilateral choked discs of 3–4 D., nystagmus on looking to the right and left, unsteady gait, apathy, and slow pulse.

On Aug. 16, Dr. Horrax did a suboccipital exploration and discovered in the left pontocerebellar angle bulging grayish tissue evidently from the cerebellar hemisphere. A portion of this tissue was removed for examination and found to be protoplasmatic astrocytoma. He recovered promptly; was given a roentgen-ray treatment on Sept. 7 of 150 ma-min., technique "A.," and discharged on Sept. 11. His optic discs at this time showed secondary optic atrophy; his gait was quite steady; he had no headaches or discomforts of any kind, although he still held his head to the right side. His nystagmus remained. With the exception that an attack of vomiting followed roentgen treatment on Sept. 7, he felt perfectly well. He remained well until Sept. 24 when he complained of numbness in his right arm. An hour or so later he began to vomit and became irrational. He was brought immediately to the

hospital and was admitted, Surg. No. 19751. He soon became quiet and co-operative in the hospital, although quite delirious on arrival. On Sept. 25 he was co-operative and feeling well. Optic discs showed no elevation; nystagmus was still present; his gait was definitely unsteady, and he was unable to stand on either foot alone. He was given a second roentgen treatment on Sept. 29, same dose, and discharged. Shortly after discharge he began again to have headaches and vomiting; lost weight; became very unsteady; he was irritable, and in November began to have attacks of unconsciousness lasting from five to twenty minutes. During these attacks his neck would become rigid; his extremities stiff; he would become unconscious and have urinary incontinence. His gait was more and more unsteady until for the last four weeks he had been in bed and was admitted to the hospital on Nov. 22, 1923, Surg. No. 20174, with a bed sore on the left hip, very sick and unco-operative, with bilateral choked discs of 2 D. elevation, dysarthria, coarse nystagmus on looking to the right and left, staggering gait and a pulse rate of 58.

On Nov. 23, Dr. Cushing re-explored the suboccipital region, disclosing the cerebellum. The entire surface seemed to be covered with tumor. By blunt dissection the midcerebellar region was opened coming down upon a solid gliomatous tumor, a portion of which was removed, but very little was accomplished and he did not do well following the operation. His discs continued choked; he was incontinent of urine and feces; but was somewhat more comfortable. He was given a roentgen treatment on Dec. 4, 1923, of 120 ma-min., and was discharged on Dec. 15. Concerning his subsequent course, it is only known that he continued to decline rapidly and died on March 2, 1924.

Impression. Three roentgen treatments had no effect on the progress of this patient's illness.

Case 39. Surg. No. 20467. *Astrocytoma protoplasmaticum in the left frontal lobe. Osteoplastic operation. Roentgen therapy, T. 704. Secondary operation. Third operation. Gradual failure and death. No necropsy.*

On Jan. 7, 1924, Joseph F., aged forty-seven, was admitted to the hospital, referred by Dr. Louis Hamman of Baltimore, Md., complaining of convulsions and difficulty of speech.

In March, 1920, he fell in a generalized convulsion and was unconscious for six hours. After this he had some speech defect and a week later another convulsion. He rested all summer on luminal therapy, and in October returned to work, complaining occasionally of headache. Soon afterwards he had an attack in which aphasia was followed by a right sided convulsion. In December, 1921, January, 1923, April and June, 1924, he had similar attacks. For the last year he was depressed and unusually quiet, untidy at the table. In June, 1923, he began to drag the right foot in walking and complained of frontal headache.

The patient was drowsy, usually euphoric, and unstable emotionally, laughing and crying without reason. He understood imperfectly what was said to him and answered irrelevantly. There was alexia, loss of memory and partial disorientation. There was a right hemiparesis and bilateral choked discs. Roentgen examination showed a dense, irregular mass of calcification in the left frontal region, just to the left of the midline.

On Jan. 12, 1924, a left osteoplastic operation was done. An immediate subtemporal decompression was made and in the subcortical region under the 1st and 2d frontal convolutions was found an extensive soft reddish vascular glioma. No attempt was made to remove it.

He was very dull following the operation and recovered slowly but on Jan. 24 he was able to walk a little and his mental condition was somewhat improved. By Feb. 3 he was able to read the financial page of a newspaper and to discuss it intelligently. On Feb. 12 he was discharged. The optic discs were flat. He was walking about, and read for hours. He was decidedly euphoric and there was occasionally paraphasia. The hemiparesis had completely disappeared.

He had roentgen-ray treatments on Jan. 21, Feb. 11, and March 3, each 150 ma-min., technique "A." Complete epilation over the left frontal area was noted on March 3. Treatments were continued by Dr. Herendeen at the Memorial Hospital, New York City, with 10 inch spark gap, 5 mm. Al filter, 15 inch distance and 100 ma-min., on Mar. 26 and Apr. 16, 1924, and 75 ma-min. on May 9, 1924. The 100 ma-min. dose was said to be just below an erythema.

On May 18, 1924, his wife reported that he still had some trouble with his speech. On July 26, 1924, she reported that he was very irritable and having occasional headache. He was re-admitted Aug. 28, 1924, Surg. No. 22063.

He was alert and co-operative with only a slight hesitation in speech. His gait was normal with no trace of his old hemiparesis. The decompression was tense but not bulging.

On Sept. 6, 1924, the old wound was reopened and a soft grayish avascular tumor was dis-

closed on the medial surface of the left frontal lobe. It was dissected away from the brain tissue and a large part of it was removed.

There was a transitory increase of aphasia, but his headaches were immediately improved. He was given his seventh roentgen treatment on Sept. 16, 150 ma-min., without any bad effects. He was discharged on Sept. 24 with some alexia and paraphasia. He was very irritable and exacting.

On Feb. 21, 1925, his wife reported that he was feeling quite well but still had slight difficulty in speaking. His eighth roentgen-ray treatment was given in New York on Apr. 7, 1925, with 100 ma-min. as before. On June 18, 1925, he had a slight convulsive attack and another one on July 8, followed by transitory weakness of the right leg. He was given luminal and had no more convulsions, but his speech difficulty increased slowly and the weakness of the right leg became slowly more marked. He was re-admitted Aug. 12, 1925, Surg. No. 24557.

The subtemporal decompression was tense and bulging. There was some haziness of the margins of the optic discs without measurable elevation, right hemiparesis, definite memory defect, irritability and aphasia.

On Aug. 15, 1925, he was given a ninth roentgen treatment and discharged. He continued to go downhill; speech difficulty, hemiparesis, headache all increased. He was re-admitted Sept. 8, 1925, Surg. No. 24688. The decompression was very full and tense. The optic discs were slightly choked, the right hemiparesis very marked and aphasia very bad, especially anomia.

On Sept. 5, 1925, the wound was reopened and a considerable amount of neoplastic tissue removed. It was very tough, and contrary to the previous occasion, also very vascular. He was very feeble for several days from loss of blood and he had a total right hemiplegia. By Sept. 15, however, he was stronger; could move his right arm and leg and speak in monosyllables. He was given a tenth roentgen treatment on Sept. 18, 1925, 150 ma-min., without any apparent result. He was discharged on Sept. 23. His headaches were relieved; the decompression was soft. Aphasia was marked and the hemiparesis about as on admission.

On Nov. 22, 1925, his wife reported that he had had two roentgen-ray treatments in New York, each 100 ma-min. as before, except that 6 mm. Al was used, but without improvement. By Jan. 25, 1926, the decompression was bulging and tense, he was almost blind and suffering from headaches.

He died at home March 27, 1926. There was no necropsy.

Impression. The roentgen treatment seemed to be without effect in this case.

CASE 40. Surg. No. 13694. *Astrocytoma protoplasmaticum, cystic, of the right temporo-occipital region. Osteoplastic operation. Roentgen therapy, T. 145. Secondary operation. Sudden coma and death. Necropsy.*

On Dec. 17, 1920, Esther W., aged nine, was admitted to the hospital, complaining of headache, vomiting and weakness of the left arm.

In March, 1920, she became unruly and no longer did well in school. It was noted at the same time that her left arm was weak and that she rarely used it. There was a tremor of the left hand when she tried to use it. In November the child had a severe headache with vomiting. On Dec. 8 she had a violent attack of vomiting during which she became cyanotic, and lately her vision seemed poor.

The child had a large head which gave a cracked-pot sound on percussion. There were bilateral choked discs of 4 D. elevation, left homonymous hemianopsia, left hemiparesis with marked tremor, spastic hemiplegia, and at the same time staggering gait.

On Dec. 31, 1920, a right osteoplastic exploration was done, disclosing a huge gliomatous cyst containing over 100 c.c. of yellow clotting fluid. This was evacuated, a subtemporal decompression was made, the cyst was filled with air, and the wound closed. Roentgen examination showed the cyst to lie in the temporo-occipital region. On Jan. 5, the wound was reopened and the cyst opened widely, disclosing in its lower anterior wall a mass of grayish tumor which was removed.

The patient recovered rapidly and was discharged on Jan. 22, 1921. At this time the discs were elevated 1–2 D., nystagmus on looking to right and left, very slight tremor of the left hand, slight weakness of left arm and leg, gait still unsteady, left homonymous hemianopsia.

She had roentgen treatments on Jan. 21, Feb. 10, Mar. 3 and Mar. 21 each 32 ma-min., 130 kv. 8 in. distance, through 6 mm. Al. During this time she improved steadily. By January, 1922, she was walking quite well and returned to school and did well until July, 1924, when her left arm became gradually weak and she began to have twitching attacks in the left arm and leg.

She was examined on Dec. 18, 1924. She had no headaches nor vomiting but the left arm and leg were much weaker than on discharge

in January. There was no choking of the optic discs.

She was re-admitted to the hospital Jan. 5, 1925, Surg. No. 22939. There was found a left homonymous hemianopsia, a bilateral secondary optic atrophy without choking, bilateral nystagmus on looking to right and left, left hemiparesis and hemihypesthesia; dull and inattentive for the most part, and she had periods of euphoria and effusiveness. On Jan. 15, the old wound was reopened and 30 c.c. of fluid was evacuated from the cyst. The surrounding tissues were gray and very tough as though a fibrous glioma were infiltrating the region. No attempt was made to remove this tissue.

She was discharged on Feb. 1. There had been marked improvement of the hemiparesis, but a curious alteration of her mental state. She was now constantly giggling, chattering and making poor jokes. She was unable to concentrate on anything and was absolutely incorrigible.

On April 8, 1925, she was seen at St. Elizabeth's Hospital, comatose, with the decompression tense and bulging. She had been in this condition for forty-eight hours. The cyst was evacuated with a lumbar puncture needle. The next morning she was bright and active. On April 25 she vomited and complained of headache which continued on April 26 and on the following day she was semicomatose. She was re-admitted April 27, 1925, Surg. No. 23736. The decompressed area was bulging but not tense. She died suddenly on April 29, 1925.

Necropsy disclosed a huge cyst of the right temporal region extending into the basal ganglia, the right cerebral peduncle and down into the upper part of the pons. In the lower wall was a nodule of grayish tumor which when examined showed the typical structure of a protoplasmic astrocytoma (Fig. 5).

Impression. Improvement following the operation of December, 1920, may be attributed to the operation itself. The effect of the rather mild roentgen treatment cannot be determined with certainty.

Case 41. Surg. No. 15499. *Astrocytoma protoplasmaticum of the cerebellum. Suboccipital exploration. Secondary operation. Roentgen therapy, T. 947. Death. No necropsy.*

On Nov. 3, 1921, Arthur P., aged sixteen, was admitted to the hospital, referred by Dr. E. T. Easton of Boston, Mass., complaining of failing vision and unsteady gait.

Since September, 1921, his vision had been failing. Occasionally there was double vision and latterly his gait was unsteady. There was no headache and no vomiting.

Examination showed bilateral choked discs of 5 D. elevation, an internal strabismus, nytagmus on looking to right and left, slight unsteadiness of gait and binasal constriction of the visual fields.

On Nov. 12, 1921, a suboccipital exploration was done which did not disclose a tumor. The cerebellum was herniated into the foramen magnum and the arachnoidal membrane was thickened.

He recovered promptly and was discharged on Dec. 10, 1921, his optic discs having receded to 2 D.

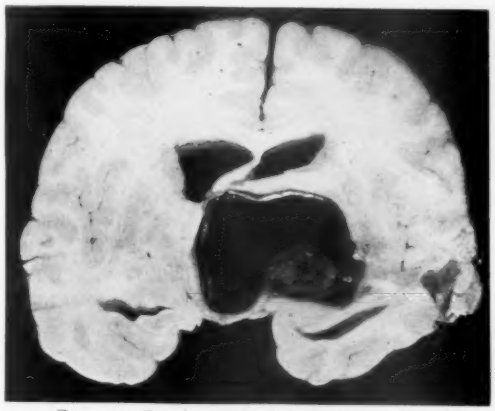

Fig. 5. Case 40. Cystic protoplasmic astrocytoma. Note the mural nodule of tumor.

In January, 1922, Dr. Easton reported that his optic discs showed no elevation, but a slight atrophy. There was still some tendency to stagger in walking, but he was at work, playing the drums in an orchestra.

He was well until Nov. 1, 1924, when he began again to suffer from headaches and vomiting and was re-admitted, Surg. No. 22625. At this time there was diminished olfactory acuity, diminished visual acuity (20/100 left, 20/40 right) and binasal hemianopsia, bilateral secondary optic atrophy with slight choking, nystagmus on looking to right and left, especially to right, staggering gait, asynergy, especially of the left arm and leg, and dysarthria.

On Nov. 29, 1924, the suboccipital region was re-explored and this time there was found an intracerebellar tumor, mainly in the left hemisphere, containing a large cystic cavity. A large portion of this tumor was extirpated.

He recovered promptly and by Dec. 14, was walking with very slight unsteadiness. His headaches and vomiting entirely ceased. Roentgen treatment of 150 ma-min., technique "A"

was followed by headache and vomiting for twenty-four hours. He was discharged on Dec. 23, 1924. There was slight nystagmus, diplopia, asynergy and dysarthria, all much less than on admission.

On Jan. 10, 1925, he vomited and had a headache all day. The following day he was re-admitted, Surg. No. 22989. He was given a large dose of magnesium sulphate and by Jan. 15 he was feeling quite well again so was discharged.

Roentgen treatments were given on Jan. 28, 120 ma-min., Feb. 18, March 11, April 1, April 22, and May 13, 1925, each 150 ma-min., none causing any definite general reaction. Epilation was complete on April 1.

He was well until October when he began gradually to develop exaggerated diplopia, a sensation as though his teeth were in a vise, an impairment of the sense of taste, lachrymation, right facial weakness, unsteady gait. Roentgen treatment was given Nov. 14, 150 ma-min., without relief. He was re-admitted on Dec. 9, 1925. There was no choking of the optic discs, an almost complete ophthalmoplegia of the right eye and sixth nerve weakness of the left, with limitation of conjugate movements upwards and downwards, nystagmus on looking to left, peripheral right facial paralysis, staggering gait, slight asynergy especially of right hand and leg.

On Dec. 16, 1925, an attempt was made to puncture the left cerebellar hemisphere with a lumbar puncture needle. About 0.75 cm. below the skin fluid was obtained, about 50 c.c. of watery fluid discolored with blood, probably from an arachnoid cyst. He was somewhat relieved and was discharged on Dec. 20, 1925.

On Feb. 12, 1926, he was re-admitted, Surg. No. 25765, in rather deplorable condition with a bilateral facial palsy, bilateral corneal ulcerations, and hypesthesia of both trigeminal areas, almost complete ophthalmoplegia, tremendous asynergia of all the extremities, and paralysis of the palate. He died the next day. There was no necropsy.

Impression. Roentgen treatment seemed to have no influence on this patient.

Case 42. Surg. No. 24308. *Astrocytoma protoplasmaticum of the left temporal lobe. Subtemporal decompression. Roentgen therapy, T.* 1087. *Apparently well November,* 1926.

On July 11, 1925, Annie A., aged forty-eight, was admitted to the hospital, referred by Dr. Wm. Walker of Brockton, Mass., complaining of convulsions and headache.

In January, 1924, while doing her housework she felt a peculiar numbness in her feet, which extended upwards and then she lost consciousness in a generalized convulsion. A second similar attack occurred in June and a third in August. Since then similar convulsions have occurred at irregular but shorter intervals. Just before and after the convulsions she suffered from severe pain in the head. Her memory was failing and at times there was some difficulty with speech especially after a convulsive attack. On examination there was found bilateral choked discs with 2–3 D. elevation. There seemed also to be a right upper quadrant defect in the visual fields although the patient was so nervous, apprehensive and uncooperative that the result of the examination was doubtful. At any rate an operation was done upon this indication. There were no aphasic symptoms.

On July 18, 1925, a left subtemporal decompression disclosed a soft gray tumor occupying a large portion of the temporal lobe, a large part of this tumor was removed with little bleeding.

She recovered promptly without any speech defect. She was discharged on August 2, 1925. There was still a right homonymous upper quadrant defect in the visual fields. The discs were still choked 1–2 D. and the decompression was bulging but not particularly tense.

She was given one roentgen treatment on July 29 without untoward result. These treatments were continued Aug. 19, Sept. 9, Sept. 30, Oct. 21, and Nov. 13, 1925, each 150 ma-min., technique "A." On the latter date she was quite jovial, free from headaches. Epilation was complete. No choking of the optic discs.

On Nov. 14, 1926, she was examined. She had been feeling perfectly well, was free from headache and speech defect. There had been no convulsions. The optic discs were flat and the decompression soft and only slightly bulging.

Impression. It is uncertain how much of the improvement in this case can be attributed to roentgen treatment. It is probable, however, that it aided in reducing the tension of the decompression and the choking of the optic discs.

Case 43. Surg. No. 25441. *Astrocytoma protoplasmaticum of right parietal lobe. Operation. Extirpation. Roentgen therapy, T.* 1174. *Death from delayed reaction (?).*

On Dec. 24, 1925, Dora F. C., aged forty-five, was admitted to the hospital, referred by Dr. Thomas J. Walsh of Buffalo, N. Y., and complaining of headache.

In the spring of 1925 she felt very tired, and was always sleepy. In September she began to drop things from her left hand, due to the fact that there was some sensory disturbance in this hand. On Dec. 4 she had a severe headache which continued and was often accompanied by vomiting. During the last two weeks she complained of a peculiar disagreeable odor.

There were found bilateral choked discs of 2 D. elevation, left hemiparesis, and hemihypesthesia. She was also very irritable and unreasonable.

On Jan. 2, 1926, a right osteoplastic operation with immediate subtemporal decompression was done which disclosed a large glioma of the right parietal lobe. The tumor was soft and not very vascular. A mass weighing 75 gm. was removed.

The patient improved rapidly and was discharged on Jan. 23, 1926. At this time headaches and vomiting had completely disappeared. The hemiparesis and hemihypesthesia had practically disappeared, leaving, however, astereognosis of the left hand. The optic discs were flat. She had been given one roentgen-ray treatment on Jan. 9, 1926, of 150 ma-min., technique "A."

After her discharge from this hospital, she was treated at the State Institute for the Study of Malignant Disease, Buffalo, N. Y., and the only information we have concerning her condition during this time is contained in the following note received from Dr. B. F. Schreiner, surgeon to the Institute:

"In reply to your letter of April 28th re Miss Dora F. C., would say she applied here for treatment Feb. 1, 1926, and was treated with high voltage X-ray divided over a period of 11 days, being treated on Feb. 1, 3, 5, 8 and 11 over the right temporal region, 30 ma., size of skin area 8 × 10, angle, 90, distance 80, time 9.1 each, skin dose 25 per cent each, total tumor dose 115 per cent. On March 12, 1926 she appeared here for observation at which time there was a marked depilatory effect on the right parietal frontal region but she felt well. She died from acute dementia on May 14, 1926."

Impression. The average life expectancy of this patient was 67+ months. She died acutely three and a half months after a series of deep therapy treatments, apparently having been well six weeks after their conclusion. Some cerebral accident was responsible and we can but venture a suggestion that it may have been a delayed irradiation reaction, possibly necrosis, or possibly a hemorrhage (although they are rare in this type of tumor) which caused her death. Unfortunately there was no necropsy.

SUMMARY

The long clinical course of these tumors in many instances without roentgen treatment makes it impossible to prove that irradiation increased the length of life of these patients, the average in these cases being seventy-eight months, in untreated cases over sixty-eight months, with great individual variation. Its influence must be judged by amelioration of symptoms, and was most apparent in Cases 32 and 37, perhaps also in Case 40.

Recurrence of symptoms in these indolent tumors may be due to many causes. It is sometimes due to malignant transformation but much more often to cystic degeneration, blockage of cerebrospinal fluid, hemorrhage into the tumor, etc., as perusal of the foregoing records will show. It is an open question whether the likelihood of these accidents may not be increased by roentgen treatment. At any rate, the attitude of the clinic at the present time is to submit all these tumors to roentgen treatment after operation because of the possibility of malignant transformation and to operate if there is a recurrence of symptoms because of the greater probability of the recurrence being due to mechanical cause.

In the literature we have found a report by Towne[24] of a case which we know from our records to be a protoplasmic astrocytoma of the cerebellum. Temporary amelioration of symptoms was obtained by roentgen therapy. Laruelle[23] also seems to have obtained temporary improvement in a case (Case 11, Desu) of astrocytoma protoplasmaticum, although the names and numbers are so badly mixed up in his report that we are not sure of having identified the tumor with certainty.

H. ASTROCYTOMA FIBRILLARE

The fibrillary astrocytomas are even more benign than the protoplasmic ones. They are very likely to be cystic and the average length of their clinical course is over eighty-six months. There are records of survival of patients ten years and more

after such a tumor has been removed at operation. Hemorrhages occur rarely, if ever, and so far as we know they never undergo malignant transformation.

CASE 44. Surg. No. 14879. *Astrocytoma fibrillare of the right temporal lobe. Right subtemporal decompression with evacuation of cyst. Right osteoplastic operation. Roentgen therapy, T. 248. Apparently well January, 1925.*

H. A. R., aged twenty-three, was admitted to the hospital July 18, 1921, complaining of headache, vomiting and failing vision, having been referred by Dr. F. E. Bunts of Cleveland, Ohio. She had been well until December, 1920, when she began to complain of suboccipital headaches. In May, 1921, she had some disturbance in vision. About the middle of June double vision appeared, and at about the same time she began vomiting.

On admission there was found bilateral choked discs of 6 D., obesity, and suboccipital tenderness with stiffness of the neck. There was no defect of the visual fields. On July 22, 1921, Dr. Cushing did a right subtemporal decompression, and about 3 cm. under the surface a large gliomatous cyst containing about 50 c.c. of fluid was found. The patient recovered promptly; headaches were relieved; but the choked discs did not subside, so that on Aug. 11, 1921, Dr. Cushing turned down a bone flap over the right temporal region. An incision was made in the temporal lobe and the cyst widely opened. In its posterior wall a tumor mass about 4 cm. in diameter was disclosed and removed. The patient recovered slowly from the operation and on Aug. 26, 1921, was given a roentgen-ray treatment and was discharged. At this time her optic discs were elevated about 3 D., with a left lower quadrant defect in the visual fields. She was given eight roentgen treatments by Dr. F. E. Bunts of Cleveland, Ohio, the details of which are not available, one every month, and on Nov. 15, 1921, he wrote that she had no headaches; the bulging of the decompression had diminished slightly, and her physical condition was excellent. On June 2, 1922, he wrote that her condition was practically unchanged. On June 24, 1923, she had occasional headaches during pregnancy, but her general physical condition was very good, and her eyesight was practically as it had been since the operation. On Dec. 12, 1924, she was delivered of a normal male child. She has not since been heard from.

Impression. The operation is sufficient to account for the present satisfactory condition, but roentgen therapy may have aided her improvement.

CASE 45. Surg. No. 15195. *Astrocytoma fibrillare of the cerebellum. Suboccipital extirpation. Roentgen therapy, T. 263. Apparently well Apr. 22, 1925.*

M. S., aged twelve, was admitted on Sept. 15, 1921, complaining of vomiting, unsteadiness of gait, and failing vision, having been referred by Dr. Edward Baxter of Chicago, Ill. It was noticed first in September, 1920, that the patient, who had previously been interested in the piano, no longer played so well and showed no interest in it. Since May, 1921, she had shown definite inability to concentrate on any work. In January, 1921, she began to vomit occasionally and in July, 1921, her gait became staggering.

On admission there was found cracked-pot sound on percussion of the skull, bilateral choked discs of 3 D. elevation, incoördination and hypotonicity of cerebellar type of all the extremities especially the right, and nystagmus on looking to the left. On Sept. 21, 1921, Dr. Cushing did a suboccipital exploration. An incision was made through the left hemisphere of the cerebellum which came down upon a fairly encapsulated tumor, containing a small cyst with about 15 c.c. of fluid. The tumor itself must have been 6–7 cm. in diameter. It was finally shelled out. There was some smart bleeding which was checked and the wound closed. The patient recovered promptly. She was discharged on Oct. 8, 1921, with optic discs subsided; headaches and vomiting relieved. Her gait was still unsteady but somewhat improved. Nystagmus was more marked and hypotonicity of the extremities unchanged. On Jan. 24, 1922, she was examined and found to be walking quite well but was nervous and had no appetite. She had been given two roentgen-ray treatments by Dr. Reynolds here on Oct. 7 and 8, 1921, one to each half of the cerebellum, with 200 ma-min., 130 kv., 12 in. distance and 0.5 mm. copper filter, and six others by Dr. Hollis Potter of Chicago on Oct. 28, Nov. 18, Dec. 16 and Dec. 31, 1921, and Feb. 2, Mar. 3, 1922. Technique 2 areas each time except the last two which were single, 130 kv., 10 in. distance, through 3 mm. aluminum, and one thickness of sole leather. Her gait was slightly unsteady but her discs were flat. There was no suboccipital fullness and no nystagmus and she was feeling quite well. Jan. 4, 1924, her father wrote that she seemed to be completely recovered; was going to school and playing tennis and hockey. On April 22, 1925, her father wrote again that she had been feeling quite well; was going to school regularly, and getting ready to take a trip to Europe.

Impression. It was not evident that the

roentgen treatments hastened her improvement. The removal of the tumor is sufficient to account for her present satisfactory condition.

Case 46. Surg. No. 15488. *Astrocytoma fibrillare of the cerebellum. Suboccipital operation with evacuation of cyst. Roentgen therapy, T. 295. Secondary operation with evacuation of cyst. Roentgen therapy. Third operation with evacuation of cyst. Roentgen therapy. Apparently well on Aug. 4, 1927.*

B. E. C., aged ten, was admitted Nov. 1, 1921, complaining of headaches, vomiting and unsteadiness of gait, having been referred by Dr. Henry Kaplovitch of Haverhill, Mass. She was well until eleven months before admission when she began vomiting in the mornings. Vomiting was preceded by dull frontal headache. Five months later it was noticed that her gait was unsteady. For the last two months she had been sleepy; yawned a good deal, and did not do her school work well.

On examination there was found a cracked-pot sound on percussion of the skull, suboccipital tenderness more marked on the right side, bilateral choked disc of 1 D. elevation in the left eye and 4 D. in the right, staggering gait with cerebellar incoördination of all the extremities, and a few nystagmoid jerks on looking to the right and left.

On Nov. 8, 1921, Dr. Cushing did a suboccipital exploration. The needle was introduced in the cerebellum to a depth of 5 cm. and obtained 20 c.c. of yellow colored clotting fluid. The cyst was at too great a depth for anything further to be done. The patient recovered promptly; her fundi subsided; and the headaches and vomiting disappeared. Her gait remained unsteady and the nystagmus persisted. She was given one roentgen-ray treatment on Dec. 1, 1921, 150 ma-min., and was discharged on Dec. 3. She continued to have treatments Dec. 20., Jan. 17, 1922, Feb. 8, 1922, each 200 ma-min. all with 132 kv., 12 in. distance, and 0.5 mm. Cu. On Jan. 17 condition was practically unchanged. On April 17, 1922, her gait was slightly improved; the fundi were flat; she had had no headaches, but had vomited once or twice in the morning.

She was re-admitted to the hospital Sept. 14, 1922, Surg. No. 17362. For about five months she had been vomiting in the morning, with dull frontal headaches. Her gait became unsteady and she gradually lapsed into her former condition.

On admission it was found that the suboccipital decompression was bulging; there was a secondary optic atrophy with no choking; her gait was slightly unsteady.

On Sept. 21, 1922, Dr. Horrax re-explored the suboccipital region and evacuated 50–60 c.c. of fluid from a large cyst, which was again at a depth which made it impossible to do more than evacuate it. She recovered promptly and on Sept. 27, 1922, she was given a roentgen-ray treatment of 150 ma-min., technique "A," which resulted in a hyperthermia the following day reaching 103°. On Oct. 3, she was up and about the ward. Her gait was still somewhat unsteady but no other symptoms remained. On Aug. 4 she was discharged. She received roentgen treatments on Oct. 17 (followed by nausea for twenty-four hours), Oct. 26, Dec. 6, Dec. 27 (when she was having morning vomiting), Jan. 18, 1923 (losing weight), Feb. 10 (somewhat unsteady), each 150 ma-min., technique "A."

She was re-admitted to the hospital on July 23, 1923, Surg. No. 19306. In February, 1923, she had begun to feel nauseated and had vomiting in the morning. In March her gait became unsteady and she had frequent attacks of hiccoughing. For the last two weeks her vision had been failing. On admission the suboccipital region was found to be bulging; there was slight choking of the optic discs; hypotonicity of the muscles of all the extremities, nystagmus, very unsteady gait, and incoördination of all the extremities, of cerebellar type.

On July 31, 1923, Dr. Horrax again exposed the suboccipital region, finding a large cyst, the walls of which were fixed with 10 per cent formalin. A portion of the wall of the cyst was removed for examination and the wound closed. Roentgen-ray treatment was given Aug. 13 and Sept. 20, 1923. Her convalescence was not so prompt as on former occasions, but she was discharged on Sept. 22, able to walk with only slight unsteadiness, with definite hypotonicity of all the extremities and very slight nystagmus. Vomiting and headaches were entirely relieved. She received further treatments on Oct. 11, 1923, and Nov. 1, each 150 ma-min., as before. On Mar. 19, 1924, no treatment was given, no symptoms being present. On April 11, 1923, treatment was followed by nausea for ten days and depression. May 7, 1924, treatment was followed by the same symptoms and no further treatments were advised. Each of these was 150 ma-min., technique "A."

Dec. 30, 1925, she looked and felt perfectly well. There was only slight hypotonicity of the extremities and slow nystagmus on looking to right and left. Her gait was quite normal.

Aug. 4, 1927, her father reported that she was perfectly normal in every way except for slight unsteadiness in walking when tired. She

was attending school regularly, playing tennis and other games like a normal child, and growing rapidly.

Impression. There is no evidence that roentgen therapy exercised any restraining influence on the course of this patient's malady. Some of the later treatments were followed by untoward symptoms and the treatments were stopped. She remains quite well.

CASE 47. Surg. No. 16164. *Astrocytoma fibrillare of the cerebellum. Roentgen therapy, T. 327. Suboccipital exploration. Roentgen therapy. Apparently well in June, 1926.*

K. E. H., aged five, was admitted Feb. 27, 1922, complaining of headache, vomiting and staggering gait, having been referred by Dr. Lester Taylor of Cleveland, Ohio. It was noticed for the first time in September, 1921, that she had headaches early in the morning, accompanied by projectile vomiting. At this time her gait became very unsteady and it was also noticed that there was some unsteadiness in the use of her left hand. She had been quite ill since August, 1922, of a middle ear infection, with involvement of the glands of the neck. She had also an infection of her left tonsil and had succeeded in infecting also her eyes and vagina with the discharge from the ear. In November her condition became worse and she was unable to walk.

On admission there was found cracked-pot sound on percussion of the head, bilateral secondary optic atrophy with some slight elevation, nystagmus on looking to the right and left, deafness in the right ear, marked unsteadiness in gait, incoördination of the extremities of cerebellar type particularly on the left side. On Mar. 21, and Mar. 22, 1922, roentgen-ray treatments were given, each 75 ma-min., 140 kv., 16 in. distance, through 6 mm. Al, crossfiring on the cerebellum, with no change in her condition.

On March 31, 1922, Dr. Cushing did a suboccipital exploration and a tumor was found bulging between the lips of the cerebellum and extending down to the spinal canal. The tumor contained a small cystic cavity. The lower portion of the growth, which extended down into the spinal canal, was removed. The patient recovered promptly and on March 23, 1922, was discharged. At this time the decompressed area was slightly bulging on the right side; her fundi showed secondary optic atrophy; her gait and other symptoms were practically as on admission, but she was very comfortable, with no headaches and no vomiting. She was given a series of eight roentgen treatments after discharge, by Dr. Walter C. Hill of Cleveland, Ohio, April 14, May 5, May 26, June 16, July 17, Aug. 4, Oct. 19, and Nov. 24, 1922, 38 ma-min., 10 in. distance, 120 kv., filtration of 4 mm. Al and 3 thicknesses of sole leather. Each treatment was double, crossfiring on the cerebellum, with 38 ma-min. on each side.

On July 10, 1922, her father wrote that she was in good health, sleeping well and had a fairly good appetite. Her gait seemed to be somewhat more steady. After the second roentgen treatment she had a very severe reaction but the others did not seem to alter her condition in any way. In August, 1922, she had an attack of hiccoughing, following which she had headaches and her gait became much more unsteady, but she recovered and on July 26, 1923, when she was examined, her fundi showed secondary atrophy with no choking. There was slight incoördination of the left hand and foot, and her gait was slightly unsteady. No nystagmus or bulging of the suboccipital region was present. She was given a roentgen treatment on Aug. 22, 1923, of 240 ma-min., 200 kv., 50 cm. distance, through 0.5 mm. Cu and 1 mm. Al, which was followed by headache and increased irritability. It was not repeated. On Jan. 8, 1924, her mother wrote that she seemed to be quite well, only occasionally irritable. Jan. 23, 1925, she was more irritable and tired very easily. She still had a secondary optic atrophy and her vision was rather poor, but she was able to do her school work and use her hands with very little disability. She was given another series of treatments by Dr. Hill, on Mar. 2, Mar. 23, Apr. 13, May 4 and May 27, 1925, each the same dose as in 1922. Her condition seems to be stationary.

June 1, 1926, her physician reported that she was quite well.

Impression. There is no evidence that roentgen therapy altered this patient's condition in any way. Some of the treatments upset her so badly that they were discontinued. The gradual improvement can be attributed to the operation alone.

CASE 48. Surg. No. 17892. *Astrocytoma fibrillare of the right frontal lobe. Osteoplastic exploration. Roentgen therapy, T. 456. Apparently well November, 1926.*

J. F. S., aged forty-eight, was admitted to the hospital Dec. 8, 1922, complaining of epileptic attacks, having been referred by Dr. H. M. Thomas of Baltimore, Md. In 1917 he began to have epileptic attacks coming on at night. During these attacks he would be

unconscious for thirty minutes or so. In 1918 he began to have these attacks in the day time. He would have a series of attacks every few months. Just before admission to the hospital he had a series of 18 attacks after which his left arm and leg were weak for several hours.

On admission to the hospital there was found a left facial weakness of central type. He had a series of epileptic attacks in the hospital which were accompanied by twitching of the left side of the face and turning of the face, eyes and head to the left.

On Dec. 12, 1922, Dr. Cushing turned down a right bone flap which disclosed an extensive tumor in the lower part of the right central region. A fragment was removed for examination and the wound closed. The patient remained dull following the operation and thirty-six hours later the flap was re-elevated and an extradural clot was removed. On Dec. 16 there was some weakness of his left arm which, however, rapidly improved. On Dec. 26 he was given a roentgen treatment of 125 ma-min., and on Jan. 2 he was discharged. At this time the weakness of his left arm had cleared up; he still had an almost constant spasm of his left face. He was given a second roentgen treatment Jan. 15, 1923, of 150 ma-min., technique "A." He was placed on luminal therapy, but continued to have occasional epileptic attacks. On Feb. 17, 1923, roentgen treatments were begun by Dr. Piersall of Reno, Nevada, using a 10 inch gap, 12 inch distance, 5 ma., 30 min., 0.5 mm. Cu filter, each over the operative area. Treatments were given with this technique on March 10, March 30, April 21, May 12, June 2, July 18, Aug. 18, Sept. 15, Oct. 13 and Nov. 3, 1923.

On April 22, 1923, the patient wrote that he always had 3–4 epileptic attacks following every roentgen treatment. He was examined on July 2, 1923, at which time he looked well, still having epileptic attacks, having had 8 in the last four weeks. His optic discs were normal. June 12, 1924, he was having slight epileptic attacks about once a week, almost completely controlled by luminal. He had not had any severe attacks since the operation. On Feb. 16, 1925, he was examined and found to be quite well; very slight weakness of the left face; fundi normal; still having an occasional slight epileptic attack about once a week.

Nov. 17, 1926. Examined. Perfectly well except for slight twitching attacks in left face. Still on luminal.

Impression. Roentgen therapy has had no influence on the course of this patient's malady, and many treatments were followed by an increase of his epileptic attacks.

Case 49. Surg. No. 19130. *Astrocytoma fibrillare of the cerebellum. Suboccipital operation with evacuation of cyst. Roentgen therapy, T. 589. Apparently well October, 1926.*

E. B., aged seven, was admitted July 28, 1923, complaining of staggering and vomiting, having been referred by Dr. Eli Friedman, of Boston. She had been well until two and a half months before admission when she began to vomit. For the last two months she had been dizzy and staggered in walking.

On admission there was found bilateral choked discs of 3 D., nystagmus on looking to the right and left, some hypotonicity and slight incoördination of cerebellar type affecting all the extremities.

On July 7, 1923, Dr. Cushing explored the suboccipital region and found a large cyst containing about 60 c.c. of fluid. In the left wall of the cyst there was a flat mass of tumor, a portion of which was removed for microscopic examination. The patient recovered rapidly, although she had a hyperthermia for a few days, and on July 24 she was discharged after roentgen treatment of 150 ma-min., technique "A," on July 23. The fundi at this time showed secondary optic atrophy with no elevation; her gait was quite steady; very slight nystagmus was present on looking to the left and very slight incoördination of the upper extremities on finger to nose test. She continued roentgen treatments on Aug. 22, Sept. 12 and Oct. 3, 1923, each 150 ma-min., technique "A."

On Aug. 22, 1923, she was quite steady on her feet; no headaches and vomiting or other discomforts. Her discs were quite flat; she was swimming and playing like a perfectly normal child. On Oct. 16, 1926, examined and found to be perfectly well. Her hair has returned over the areas treated.

Impression. Her rapid improvement after operation indicates that her present satisfactory condition is to be attributed to the operation rather than to the roentgen treatments.

Case 50. Surg. No. 20153. *Astrocytoma fibrillare of the cerebellum. Suboccipital exploration. Roentgen therapy, T. 680. Apparently well December, 1926.*

F. F. P., aged eight, was admitted on Nov. 19, 1923, complaining of headache, vomiting and staggering gait, having been referred by Dr. Charles A. Thigpen, of Montgomery, Ala. He began to have headaches in February, 1923, following an attack of measles. Similar

headaches have occurred occasionally since then, accompanied by vomiting. In September, 1923, it was noticed that he staggered in walking. He began to complain of difficulty with his vision at this time.

On admission there were found bilateral choked discs of 4–5 D., hypotonicity of the extremities more marked on the right side, staggering gait, some incoördination especially of the upper extremities, paresis of the left external ocular muscle, nystagmus on looking to right and left.

On Nov. 22 a ventriculogram was made which showed symmetrically dilated ventricles. The ventriculogram was made because examination of the visual fields seemed to show a right homonymous notch which was, however, not corroborated. Following the ventriculogram he had a sharp rise in temperature with headache, vomiting and drowsiness, and became irrational.

On Nov. 30 Dr. Cushing did a suboccipital exploration. There was found a solid tumor in the middle of the cerebellum, tough and grayish in color, a portion of which was removed and the wound closed. He recovered promptly and was discharged on Dec. 17, 1923, after one roentgen treatment of 150 ma-min., technique "A," on Dec. 14. His choked discs had subsided to 1 D.; he was walking much more steadily than on admission. There was no nystagmus and no headaches, and he was much brighter. There was still some incoördination of the upper extremities on finger to nose test. He improved steadily after discharge. On Feb. 10 he still had some incoördination of his upper extremities but his discs were flat. His walking was slightly improved and he had no headache or vomiting. He was given roentgen therapy by Dr. Boswell of Montgomery, Ala., on the following dates: Jan. 4, 1924, each side of cerebellum, 150 ma-min., 130 kv. 12 inch distance, 6 mm. Al and 0.5 mm. lead.; Feb. 16, Mar. 28, each 240 ma-min., 175 kv., 50 cm. distance, 1 mm. copper; May 29, June 13, July 18, Aug. 20, Sept. 2, Oct. 25, 1924, Jan. 1, Mar. 18, and April 16, 1925, each 300 ma-min., 175 kv., 50 cm. distance, 1 mm. copper. The treatments, except the first, were alternately given to the right and to the left sides of the cerebellum.

May 27, 1924, his father wrote that his walking varied, sometimes better, sometimes worse, but that he had gained in weight and was feeling quite well. On Oct. 25, 1924, he was going to school; was able to ride a bicycle, and his condition was apparently unchanged. In April, 1925, his condition still continued about the same.

Dec. 15, 1926, his father reported he was quite well and growing normally.

Impression. This patient's condition improved rapidly after operation and would most likely have remained satisfactory without roentgen treatment.

CASE 51. Surg. No. 22417. *Astrocytoma fibrillare in the corpus callosum. Osteoplastic operation. Roentgen therapy, T. 919. Secondary operation. Death. Necropsy.*

Benjamin S., aged twenty-eight, was admitted to the hospital on Oct. 18, 1924, referred by Dr. S. W. Crittenden of the U. S. Veteran's Bureau, complaining of convulsive attacks, headaches, and failing vision.

In November, 1921, he had headaches. In September, 1923, he felt tired all the time and had a convulsive attack beginning with twitching of the left leg. Severe headaches began in January, 1923. In September, 1924, another epileptic seizure occurred. Since this time these attacks had been increasing in frequency.

On examination there was found bilateral choked discs of 2–3 D. elevation, visual acuity 20/70 in each eye, nystagmus on looking to right and left, left hemihypesthesia and hemiparesis.

On Oct. 31, 1924, a right osteoplastic operation was done with immediate subtemporal decompression. There was a subcortical tumor in the postcentral region. It was very tough. A portion was removed for examination.

There was a transitory hemiplegia but this improved gradually. At discharge on Nov. 17, 1924, the optic discs were still choked 1–2 D. He had regained sufficient power in the left leg to be able to walk. Headaches were relieved.

He was given roentgen-ray treatments on Nov. 14, Dec. 5, Dec. 29, 1924, Jan. 19, Feb. 9, Mar. 2, May 2, May 25, and June 15, 1925, each 150 ma-min., technique "A."

On March 2 it was noted that the decompression was bulging slightly but soft. The left optic disc was clear and flat; the right was hazy, the veins tortuous and the margins obscure. He was having no headaches. Left hemiparesis. He was having occasional convulsive attacks.

When he came for treatment on June 15, he was apathetic and the optic discs were elevated 1 D.

In July, 1925, the left leg became very weak and the decompression bulged markedly. He began to have severe headaches and was re-admitted to the hospital on Aug. 3, 1925, Surg. No. 24488.

At this time there was a left hemiplegia. The

patient lay in a drowsy condition. He seemed unable to co-operate in the examination. The decompressed area was bulging and tense. The optic discs were elevated 2–3 D.

On Aug. 8, 1925, the old bone flap was reflected. Incision into the hemisphere came down upon a dilated ventricle. In its wall could be seen a yellowish tumor, a portion of which was removed for examination and the wound closed.

The following day he became stupid, the decompression was tense, and a hyperthermia developed. He died on Aug. 11. Necropsy disclosed an extensive glioma of the corpus callosum extending into the hemispheres (Fig. 6).

Impression. Roentgen therapy produced no improvement of this inoperable tumor. The tumor seems to have caused recurrence of symptoms by blocking cerebrospinal fluid circulation.

Case 52. Surg. No. 11386. *Astrocytoma fibrillare of the right postcentral region. Osteoplastic operation. Roentgen therapy, T. 918. Apparently well December, 1926.*

On Oct. 14, 1924, T. J., aged thirty-six, was admitted to the hospital referred by Dr. James A. Gage of Lowell, Mass., complaining of convulsive attacks.

He had been well until June, 1920, when he had without warning a generalized convulsion with loss of consciousness. During the next three months he had three similar attacks, all without warning. The attacks continued but since this time there had always been twitching of the left hand and leg for several seconds before loss of consciousness. Lately there was some weakness of the left leg and slight headache.

There was found on examination some slight haziness of the optic discs but no measurable elevation, a fine sustained nystagmus on looking to the right and left, a left hemihypesthesia and hemiparesis.

On Oct. 30, 1924, a right osteoplastic operation was done disclosing the margin of a glioma in the postcentral region near the midline. A part of the fibrous tumor was removed. It contained a small cyst in its central portion. A subtemporal decompression was made.

There was an immediate marked increase in the left hemiparesis predominating in the hand, but this gradually improved. He was given a roentgen-ray treatment on Nov. 14 of 150 ma-min., technique "A," with no bad effects. He was discharged on Nov. 17. At this time he was walking with only slight weakness of the left leg. The decompressed area was slightly full.

He was treated on Dec. 5. He was free from headache at this time. Again Dec. 26, 1924, Jan. 16, Feb. 6, 1925, he reported for treatment, complaining of fainting spells. He had had one convulsive attack the week before. He was treated again on Feb. 27. At this time the decompression was soft. There was complete epilation; secondary atrophy of the optic discs but no choking. He was treated on Mar. 20, April 10 and June 23. He was having occasional convulsive attacks but they were fairly well controlled by luminal. Treatment also on July 14, Aug. 4, Aug. 24, and Sept. 14. Each treatment was 150 ma-min., technique "A," except that of Feb. 6, 1925, which was 120 ma-min.

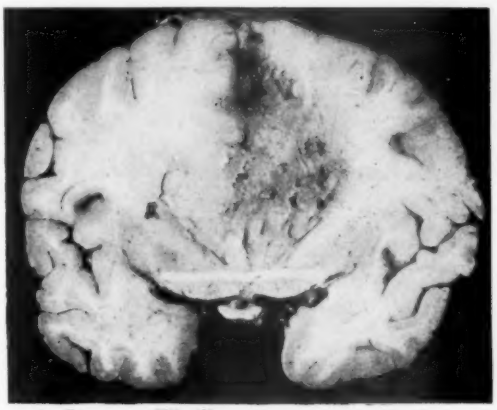

Fig. 6. Case 51. Fibrillary astrocytoma of the corpus callosum and adjacent portions of both cerebral hemispheres.

He was seen on Dec. 14, 1925. He was having local convulsive attacks in the left hand but without loss of consciousness. His grip was about equal in the two hands. There was no choking of the optic discs. The decompressed area had been covered by new bone.

On Dec. 14, 1926, he wrote that his eyesight was good but that he could not use the left side very well and was having convulsive attacks with loss of consciousness every four or five weeks.

Impression. No favorable effect of irradiation was seen in this patient. It seemed to have no effect on his epileptic attacks.

Case 53. Surg. No. 20509. *Astrocytoma fibrillare of the cerebellum. Suboccipital operation. Evacuation of cyst and removal of mural tumor. Roentgen therapy No. 716. Apparently well in August, 1927.*

On Jan. 13, 1924, Marcia E. T., aged five,

was admitted to the hospital, referred by Dr. C. A. Raeder of Omaha, Neb., and complaining of headache and vomiting.

It was first noticed that she vomited during an attack of whooping cough in March, 1923. At the same time she complained of pain in the back of her head. After the cough had disappeared she continued to suffer from headaches and vomiting. In December, 1923, a lumbar puncture was done causing increased headache and retraction of the neck. Since Jan. 1, 1924, her condition had improved; her head became larger, and she was very clumsy especially with the right hand.

On admission there was found a marked hydrocephalus with cracked-pot sound on percussion, bilateral choked discs of 4–5 D. elevation, suboccipital tenderness, internal strabismus of the right eye, and marked hypotonicity and dysmetria of all the extremities. She was unable to walk.

On Jan. 21, 1924, a suboccipital operation was done disclosing a large cyst of the right cerebellar hemisphere, in the wall of which was a large bulging tumor. A large mass of tumor was removed and it was proved to be an astrocytoma.

Course of Illness. She recovered promptly and was discharged on Feb. 6, 1924. Her optic discs had subsided. She could stand alone and walk with assistance. Headaches and vomiting were completely relieved.

She was given roentgen-ray treatments here on Feb. 1, 1924, of 150 ma-min., technique "A," and treatments were continued by Dr. A. F. Tyler of Omaha, Nebr., on March 2, and April 2, 1924, using 9.5 inch spark, 0.5 mm. Cu filter, 12 inch distance, 150 ma-min.

Her mother reported that in December, 1926, she was "well and perfectly normal in every way." Her physician and her father reported in August, 1927, that she was quite well and happy.

Impression. This patient had very little treatment, and considering the nature of the tumor, the operation alone is sufficient to account for her present satisfactory condition. If a long series of treatments had been given without knowing the nature of the tumor this period of forty-three months of perfect health would be considered a triumph of radiotherapy. Her average expectancy, however, *without roentgen rays or radium*, would be 87+ months.

SUMMARY

All of these patients are alive and well except one, where probably the block of cerebrospinal fluid was not relieved by the operation. It would be possible to make out a good case for roentgen treatment from these patients did not one know that these tumors are very benign and go, without irradiation, ten years and more without recurrence of symptoms. It cannot be said that roentgen therapy has prolonged the life of any one of these patients. No immediate beneficial effect was seen in any instance. The symptoms in Case 30 recurred under treatment and remained absent after the third operation, after which no treatment was given. In 2 cases treatments were stopped because they gave rise to disagreeable reactions.

We can see no reason for submitting tumors of this type to roentgen treatment. Recurrence of symptoms is almost certain to be due either to refilling of a cyst or to blockage of cerebrospinal fluid circulation.

D. ASTROBLASTOMA

These tumors are only relatively benign, in rapidity of growth lying between the spongioblastoma multiforme and the protoplasmic astrocytoma. They contain many amitotic cellular divisions as well as frequent mitoses. They may possibly increase in malignancy as do the protoplasmic astrocytomas.

Case 54. Surg. 19514. *Astroblastoma of the left post-central region. Osteoplastic extirpation. Roentgen therapy, T. 619. Secondary operation, no subsequent roentgen treatment. Third operation. Roentgen therapy. Death. No necropsy.*

M. S., aged forty-three, was admitted Aug. 22, 1923, complaining of headaches, numbness of the right hand and convulsive attacks, having been referred by Dr. Israel Strauss of New York City.

She had been well until the middle of June, 1923, when she began to have rather frequent frontal headaches. She stated also that her right hand was occasionally numb so that she had difficulty in holding small objects. At first this sensation was intermittent, but soon became permanent. On the 13th of August suddenly she began to have twitching of the muscles of the right hand which spread to the right side of the face. At this time she lost control of her speech for a few moments.

On admission to the hospital there was found a right hemihypesthesia, more marked on the ulnar side of the right arm, and weakness of the right arm, especially in the small muscles

of the right hand. There was practically no sensory disturbance of the leg; tendon reflexes of the right arm were brisker than those of the left. There were no aphasic symptoms and the optic discs were normal. On Aug. 24, she had a convulsive attack, which consisted of twitching of the right side of the face and hand and lasted for about five minutes without loss of consciousness. The neck was not involved.

On Aug. 28 Dr. Cushing turned down a left bone flap and when the dura was reflected, there was seen a bulging soft hemisphere with wide and flattened convolutions. An immediate subtemporal decompression was performed, and a transcortical incision made in the post-central gyrus over the arm area. At a depth of 1 cm. it came down upon a fairly definite circumscribed grayish-red tumor mass. It was possible by blunt dissection to separate it from the surrounding brain, although it was not definitely encapsulated. When removed it measured about 3 cm. in diameter.

The day following the operation the patient was very stuporous and did not seem to recognize people. The right arm was held rigidly in semiflexion. The second day, however, she was brighter and on Sept. 2 she was sufficiently recovered for an examination to be made, when it was found that she had a motor aphasia, spontaneous speech being reduced to a few words. Comprehension of speech was good. She had a right hemiplegia. She gradually recovered from her hemiplegia, movements appearing first in the leg. Roentgen treatment was given Sept. 11, 1923, 150 ma-min., technique "A." On Sept. 16 she was able to flex her elbow and to adduct and abduct her right shoulder. Her speech had also improved so that she was able to carry on a conversation, although she had often to stumble over words. A second roentgen-ray treatment was given Oct. 2, 1923, same dosage. She was discharged on Oct. 4, 1923. At this time she had movements in all the muscles of the right side with the exception of the small muscles of the hand. She still spoke with some hesitation. Her general health was excellent. She was feeling perfectly well. After her discharge she was given roentgen treatments by Dr. Chas. Gottlieb of New York City, and on Oct. 23 and Nov. 13, received 120 ma-min. each, 220 kv., through 0.75 mm. Cu; distance not stated, presumably 50 cm. The fifth roentgen treatment was given at the Brigham Hospital on Jan. 3, 1924, again 150 ma-min., technique "A," and a sixth, same dose, on Jan. 23, 1924. On Jan. 24, 1924, she was examined, at which time her decompressed area was flat; she was able to open and close her right hand, although she was far from having normal strength. She complained that from time to time she had twitching attacks in the right hand, but otherwise she was perfectly well.

On Jan. 27, 1924, she had a rather severe convulsive attack, accompanied by loss of consciousness and vomiting, four days after roentgen-ray treatment. After this attack she continued to improve steadily and by Sept. 2, 1924, her facial paresis had disappeared; she was still unable to use her right hand although able to flex and extend the fingers to a certain extent. She was walking with some slight spasticity and weakness of the right leg. The subtemporal decompression was collapsed. She had no headache whatever. Her speech was slightly hesitant for complicated words. She still had some minor twitching attacks from time to time in the right arm, which were, however, very well controlled by luminal.

Except for occasional convulsive attacks, she was fairly well until October, 1925, when she became weaker and began to have difficulty in finding words. She was re-admitted on Nov. 2, 1925, Surg. No. 25108.

The subtemporal decompression was bulging and tense. There was secondary atrophy of the optic discs without choking, right hemihypesthesia, right spastic hemiparesis, and a marked aphasia.

On Nov. 7, 1925, the old bone flap was re-elevated, disclosing the surface extension of a vascular, reddish-brown tumor in the left post-central region. A large part of the superficial portion was removed. In the deeper part was a ragged cystic cavity containing 30 c.c. of yellow clotting fluid.

She recovered strength in the right arm and her speech improved greatly. She was discharged Nov. 24, 1925, no roentgen therapy to be given.

Because the decompression was bulging and speech defect increasing, she was re-admitted Feb. 5, 1926, Surg. No. 25729. The decompression was soft but both the aphasia and hemiparesis were more evident than at the time of last discharge.

On Feb. 13, 1926, the old operative wound was reopened and a huge cyst evacuated. Some fragments of neoplastic tissue were also removed from its wall. Both hemiparesis and aphasia improved promptly and she was discharged on March 2, 1926.

The decompression became slowly tense again, with increase of aphasia and paresis. She was re-admitted April 16, 1926, Surg. No. 26175. On April 17, 1926, the wound was reopened and a large soft nodular tumor weighing 125 grams was removed. She improved slowly and was discharged on May 15, 1926.

Roentgen-ray treatments were given on April 21 and May 13, 1926, each 150 ma-min., technique "A," without bad effects. Four more were given in New York City by Dr. Maurice Lenz, June 2, 33 per cent skin unit dose, June 23, 66 per cent skin unit dose, July 15, 50 per cent skin unit dose, and Aug. 5, 66 per cent skin unit dose, each with 140 kv., 4 mm. Al, 50 cm. distance, 10 × 10 cm. portals, 4 ma., and 10, 20, 15 and 20 minutes respectively, directly over the operative area, but she continued to grow weaker, soon developed a complete aphasia, was bedridden and died Feb. 5, 1927.

Impression. It is difficult to decide whether the roentgen treatment prolonged the life of this patient in view of the repeated operative interference. Many of the treatments resulted in severe reactions, particularly exaggeration of the epileptic attacks.

Case 55. Surg. No. 20487. *Astroblastoma of the medial surface of the right parietal lobe. Right osteoplastic extirpation. Roentgen therapy, T. 7-14. Death eight months later. Necropsy.*

C. H. J., aged thirty-three, was admitted to the hospital Jan. 10, 1924, complaining of convulsive attacks, having been referred by Dr. W. D. Ayer of Syracuse, New York. He had been well until August, 1923, when he had a convulsion during the night. About a week later during the day he had a second attack which began with twitching in his left leg, extending to his hand and arm on that side, during which he lost consciousness for ten to fifteen minutes. He had a slight headache after it. Two weeks later he had a similar attack. These attacks increased in frequency. Gradually his left leg became very weak, so that he could not bear his weight on it. His left arm was also very weak and numb. For the last two weeks he had daily headaches. During one of his attacks he was unable to speak.

On admission there was found paralysis of the left arm and leg, absent abdominal and cremaster reflexes on the left side, slight hypesthesia of the left side of the body and normal fundi. On Sept. 19, 1923, a small bone flap had been turned down over the right parietal region, but the patient says nothing was found.

Jan. 15, 1924, Dr. Cushing turned down a large parietal bone flap on the right side and a large tumor was disclosed in the parasagittal region. The mass of the tumor removed weighed 108 gm. He was very weak following the operation but recovered promptly. On Jan. 31 and Feb. 25, roentgen-ray treatments were given, each 150 ma-min., technique "A." On March 2, 1924, he was quite comfortable; was able to walk; complained of tingling in his left arm and leg; his left arm had practically recovered so that the grip was equal on the two sides; the left leg continued to be weak and spastic.

He was discharged on March 6, 1924. He was given roentgen treatments on Mar. 17, Apr. 7, Apr. 28, May 5, June 9, June 23, and July 28, each 125 ma-min., 130 kv. 12 in. distance, through a filter of 0.25 mm. Cu and 1 mm. Al, by Dr. Childs of Syracuse, N. Y., sometimes with a very severe reaction. On June 23, following such treatment he went into status epilepticus for five hours, so the time was reduced to 15 min. for July 28 treatment. On Sept. 6 he had a severe convulsive seizure followed by hyperpyrexia. His temperature came down for a short time but he never became quite clear mentally. He was very dull and would not eat. He died Oct. 1, following a week of hyperpyrexia and apparent coma. At no time was there any choking of the optic discs or signs of increased intracranial tension. Necropsy was obtained and sections of the brain showed only slight evidence of tumor at the site of the operation.

Impression. Roentgen treatment certainly did this patient no good. It seems legitimate to question whether it might not be responsible for his fatal convulsions and hyperpyrexia.

Case 56. Surg. No. 18864. *Astroblastoma, cystic, of the right parietal region. Osteoplastic operation. Secondary operation. Roentgen therapy, T. 602. Apparently well October, 1926.*

On May 19, 1923, George P., aged six, was admitted to the hospital, referred by Dr. James Glass, of Framingham, Mass., complaining of headache, loss of vision and weakness of left arm and leg.

April 16, 1923, he returned from school complaining of headache and vomited twice. He also saw double. Vomiting and headache continued for about two weeks. On April 22, there was noticed weakness of the left arm and leg. His condition remained about the same since, except that his vision slowly failed.

He was an emaciated child but bright and co-operative. There was a cracked-pot sound on percussion of the skull. The optic discs were choked 3–4 D. with hemorrhages and secondary atrophy. He could see only large objects. There was also bilateral sixth nerve paresis, left hemihypesthesia, and left flaccid hemiparesis, with, however, a positive Babinski sign. He

later developed paralysis of lateral conjugate movements of eyes. He complained of pain in the left side, especially in the hip.

Course of Illness. On June 4, 1923, a trephine opening was made in the right parietal region. A brain puncture needle was introduced and at a depth of 5 cm. a large gliomatous cyst was evacuated of about 100 c.c. of yellowish fluid, and 80 c.c. of air was injected into the cyst, for roentgenographic purposes.

Following this procedure, he complained less of headache but was much terrified by visual hallucinations seeing men with guns, dogs, etc.

On June 7, 1923, a right osteoplastic operation was done. The huge cyst was opened and its interior fixed with Zenker's fluid. A portion of the cyst wall was removed, but the tumor was very vascular and the wall so extensive that a complete extirpation was thought to be impossible.

He was very weak following the operation. The left arm was completely paralyzed. The optic discs subsided somewhat with secondary atrophy and practically complete blindness. The bone flap began to ride up so that it seemed certain the cyst was refilling.

On July 16, 1923, the bone flap was re-elevated and a mass of tumor weighing 144 gm. was removed.

The patient recovered promptly. The left arm regained movement but he remained blind. He was discharged on Aug. 12, 1923. The optic discs were flat. There was a left spastic hemiparesis predominating in the arm, conjugate movements of the eyes were normal.

He had roentgen treatments on Aug. 10, Aug. 31, Sept. 21, Oct. 11, and Nov. 1, 1923, each 150 ma-min., technique "A." There were no bad effects from any of these treatments and he continued to improve slowly during the entire period. On Oct. 11, epilation was complete. Treatments were then discontinued.

On April 28, 1924, he was feeling well although completely blind. There was some weakness of the left arm but none of the left leg.

On Oct. 16, 1926, he was examined. Except for the blindness he seemed a perfectly normal boy of his age. There was only slight weakness of the left hand.

Impression. Roentgen therapy may be in part responsible for the long survival of this patient, but it must be remembered that the extirpation of the tumor was radical and apparently complete.

SUMMARY

Although there is no conclusive evidence from our experience that these tumors are influenced by irradiation, we should think it advisable to give a course of treatments after operation because the tumors contain fairly numerous mitotic figures and are liable to recur. Attention might again be directed to the exaggeration of epileptic attacks by roentgen treatment in two of these patients.

E. OLIGODENDROGLIOMAS

These tumors, although very cellular, are benign and subject to calcification. There is some evidence that they may increase in rapidity of growth occasionally.

CASE 57. Surg. No. 13924. *Oligodendroglioma of the left central region. Osteoplastic exploration with evacuation of cyst and partial extirpation. Roentgen therapy, T. 152. Secondary operation. Third operation. Apparently well January, 1927.*

P. E. M., aged forty-three, was admitted Jan. 27, 1921, complaining of headaches and convulsive attacks, having been referred by Dr. C. J. Durham of Muskegon, Mich.

He had been well until 1904 when he had a generalized convulsion with unconsciousness. After that he had several other convulsive attacks at intervals of from three weeks to a year. In 1915 his memory, which had been unusual up to that time, began to fail. Since September, 1920, his attacks were more frequent, and he began to have minor attacks during which he would lose the ability to speak for a few minutes. After the attacks he would have headaches for a day or so.

On admission to the hospital he had a right facial paresis, some impairment of memory, haziness of the upper margins of both discs, with slight dysarthria and some hesitation at times in speaking. A roentgen examination of the head showed a definite area of calcification in the left hemisphere in about the region of the central fissure. On Feb. 2, 1921, Dr. Cushing turned down a left bone flap disclosing a large tumor, about 4.5 cm. in diameter, lying just in front of the fissure of Rolando. This tumor contained a cystic cavity from which 30 c.c. of fluid was evacuated. A portion of the tumor was removed and the wound closed. Following the operation his speech difficulty was slightly increased, but this later improved. Roentgen-ray treatment was given Feb. 14, 1921, 40 ma-min., 132 kv., 8 in. distance through 5 mm. Al, and Feb. 24 he was discharged with the facial paresis somewhat improved, optic discs unchanged and his speech defect somewhat better. Roentgen-ray treatments were continued by Dr. Hollis

Potter of Chicago, Mar. 9, Apr. 4, four areas each, May 18, June 9, July 8, July 29, Sept. 3, Oct. 11, Nov. 12, 1921 and Feb. 1, 1922, three areas each, with 8 in. spark gap, 10 in. distance, and a filter of 3 mm. Al and 1 thickness of sole leather, 36 ma-min. over each area except the last two series, which received 42 ma-min., each area. He continued to have epileptic attacks about every three weeks until May 1, 1924, when he began again to have speech difficulty and impairment of motion of his right arm and leg. Since that time he had felt weak and miserable. His speech had grown worse and worse. He began to drag his right leg in walking. He didn't understand very well what he read. He was re-admitted to the hospital on Aug. 26, 1924, Surg. No. 22046, with some slight haziness of the left optic disc. He had a very slight right hemiparesis especially of the face. The right side of the body was colder and perspired more easily than the left. He had a very pronounced aphasia both motor and sensory. On Aug. 29, 1924, a roentgen treatment of 150 ma-min., technique "A," was given without benefit. On Sept. 4, 1924, Dr. Cushing re-elevated the old bone flap, evacuated a cystic cavity containing about 30 c.c. of fluid and removed a great deal of the mass of the tumor which was not definitely circumscribed. Following the operation, his aphasia improved gradually and on Sept. 18, 1924, he was given another 150 ma-min. roentgen treatment, and discharged. At that time he was feeling well; the decompression was soft; he had a slight right facial paresis; and there had been some improvement in his ability to talk and read. On Feb. 6, he wrote that he was feeling well, had had no epileptic attacks since May 30, 1924, scarcely ever had headaches, and was back at work in his office. Further roentgen treatments were given by Dr. Vernon Moore of Grand Rapids, Mich., on Oct. 13, Nov. 4, Nov. 26, Dec. 22, 1924, and Jan. 14, 1925, crossfiring through 3 areas, each area receiving 18 ma-min., with 8 in. gap, 10 in. distance, 3 mm. Al filter.

On March 23, 1925, he was examined by Dr. V. G. J. Stuart of Grand Rapids, who could find no paresis or sensory disturbances, or in fact, any defect of his nervous system or his mentality.

In September, 1926, he began to have twitching attacks of the right side of the face, accompanied by numbness of the right hand, and on two occasions (October, 1925 and May, 1926) there were convulsions with loss of consciousness. Lately there was increased difficulty in speaking. He was re-admitted on Dec. 6, 1926, when the old operative incision was reopened disclosing a reddish-gray tumor about 4 cm. in diameter in the supramarginal region, which was shelled out apparently completely.

There was an increased paresis of the right arm which persisted, but his speech was slightly improved. He was discharged on Dec. 26, 1926.

When last heard from on Jan. 10, 1927, he was feeling quite well and having only an occasional attack of twitching of the right side of the face. This continued improvement seems rather remarkable since the tumor removed at the last operation was definitely increased in malignancy and contained numerous mitotic figures.

Impression. It is difficult to judge of the effect of roentgen treatment in this case, since the treatments were given immediately following successful operations. It is not certain that they retarded recurrences of the tumor, which, at least until the last operation, appeared to be slowly growing, only rare mitoses being found. He had symptoms seventeen years before his first operation.

Case 58. Surg. No. 20125. *Oligodendroglioma of the right frontal lobe. Right osteoplastic exploration. Roentgen therapy, T. 6-74. Death in status epilepticus. Necropsy.*

E. C., aged thirty-three, was admitted Nov. 15, 1923, complaining of headaches, failing vision and convulsions, having been referred by Dr. William Leitman of Boston. For the past five years she had complained of occasional severe frontal headaches coming on at intervals of one to four weeks. About one and a half years before admission she became quarrelsome and obstinate, and a year later had a series of convulsions usually coming on at night. About this time she began to have difficulty in vision and three months later vomiting set in.

On admission to the hospital there were found bilateral choked discs 3-4 D., loss of memory, euphoria, inability to concentrate, and a definite lack of understanding of her situation. There was a tremor of the hands, and nystagmus on looking to the right. Roentgen examination showed a calcified tumor in the right frontal lobe.

On Nov. 28, 1923, Dr. Bailey turned down a bone flap over the right frontal lobe disclosing an extensive surface tumor in this region. An incision was made through the second frontal convolution and carried down about 1 cm. coming upon tough vascular tumor tissue which could not be sucked out with a suction apparatus. A piece was removed for microscopic study, a generous subtemporal decompression was made, and the bone flap was

removed, although the dura was closed over the upper portion of the defect. The patient recovered promptly; her choked discs subsided, leaving a very marked secondary optic atrophy; she became much more sensible and co-operative, less facetious and indecent in her speech. Roentgen treatment was given on Dec. 11, 1923, 120 ma-min., technique "A." She was discharged on Dec. 25, the decompressed area bulging markedly. She returned for roentgen treatments from time to time, Jan. 2, Jan. 23 (120 ma-min. each), Feb. 13, Mar. 11, April 1, 1924, and Mar. 28, May 15, 1925, 150 ma-min., each, technique "A." Luminal was given to control her epileptic attacks. She was comparatively free from symptoms for a year, when she had a convulsion and after that had several attacks. Her decompression became quite soft and relaxed under roentgen therapy. She returned to her husband; took care of her family, and seemed to be doing quite well until May 20, 1925, five days after her last roentgen treatment, when she went into status epilepticus and was re-admitted to the hospital, Surg. No. 23197. She recovered promptly, and on examination it was found that the decompressed area, although full, was quite soft. Her euphoria was as marked as on her previous admission; fundi showed marked secondary optic atrophy; the roentgen-ray showed an even more pronounced calcification than on previous admission, located in the right frontal region. Since she had ceased to take luminal, it was considered that perhaps these convulsive attacks could be controlled by proper medical therapy; she was given a prescription for luminal and discharged.

Roentgen treatments were given June 3 and June 24. She continued to perform her household duties but was inattentive and listless. On Oct. 18 she had a series of convulsive attacks and was admitted to the hospital Oct. 19, 1925, Surg. No. 25020, in status epilepticus. She died Oct. 25, 1925, without having regained consciousness.

Necropsy disclosed an extensive multicystic glioma of the right frontal lobe.

Impression. In this case, the subsidence of the cerebral hernia may most likely have been due to the effect of the roentgen rays on the numerous blood vessels of the tumor. There was an occasional unfavorable effect upon the epileptic attacks.

CASE 59. Surg. No. 4636. *Oligodendroglioma of left supramarginal gyrus. Osteoplastic operation without disclosing lesion. Secondary operation nine years later. Roentgen therapy, T. 10-71. Apparently well June, 1927.*

On April 26, 1916, Marion M., aged forty-five, was admitted to the hospital referred by Dr. R. A. Benson, of New York City, complaining of convulsive attacks.

In 1913 during the night she was awakened by twitching of the right side of the face. She then lost consciousness and on awakening found she had bitten her tongue. Similar attacks recurred at irregular but over shorter intervals. Since 1913 the attacks have been accompanied by or preceded by a prickly sensation in the right side of the body. Lately the seizures were of almost daily occurrence, but without loss of consciousness and were accompanied by defect of speech.

There was found only a partial anosmia and right hemihypesthesia. The optic discs showed possibly slight hyperemia.

Course of Illness. She was discharged for a few days while awaiting operation and was re-admitted on May 3, 1916, Surg. No. 4683. On May 4, 1916, a left osteoplastic operation was done with an immediate subtemporal decompression. The postcentral convolutions seemed broadened and more resistant than normally, but incision into the cortex disclosed no tumor.

The operation was followed by a series of severe convulsions, but after a few days she began to recover rapidly and was discharged May 19, 1916, in practically the same condition as on admission.

She continued to have epileptic seizures at irregular intervals with or without loss of consciousness. In 1917 there was some permanent difficulty in speech with definite anomia. During the last year a paresis of the right arm gradually developed.

She was re-admitted on June 8, 1925, Surg. No. 24047. At this time she was quite euphoric. There was definite speech defect with paraphasia and perseveration, right hemihypesthesia, slight motor defect of the right hand, especial difficulty in "lifting 90," exaggeration of the tendon reflexes of the right arm and leg with positive Babinski sign on the right side. The decompression had been completely covered over with bone.

On June 11, 1925, the old osteoplastic incision was reopened. In about the region of the supramarginal gyrus there was seen the grayish surface extension of an underlying tumor, a portion of which was removed. It was very tough and extended diffusely into the surrounding tissue.

Her condition was not made worse by this procedure and on June 29, 1925, she was discharged. Her speech seemed even a little improved.

On June 22, 1925, the left temporal area was

treated. On July 13, 1925, a second treatment was given. She was feeling well, there were no headaches. Her speech was improved, also the right hand.

Sept. 10, 1925, third treatment. The decompression was sunken, motion in right arm improved. Astereognosis of right hand. Aphasia unchanged.

Oct. 3, 1925, fourth treatment, each 150 ma-min., technique "A." Condition unchanged.

Her husband reported on June 15, 192-, that she was quite well with the exception of occasional twitching attacks in the right hand. The roentgen-ray treatment had been stopped because she was worse after each one.

Impression. Treatments were abandoned in this case because of unfavorable reactions.

SUMMARY

No definite improvement due to roentgen treatment can be conclusively demonstrated in any of these cases. There was definite subsidence of the cerebral hernia in Case 28 which can possibly be accounted for by the effect of the roentgen rays on the numerous vascular channels of the growth. It cannot be said that roentgen irradiation increased the length of life of the patients for these are slowly developing tumors with an average survival period of over sixty-six months.

In Case 58 there was a serious reaction following the treatment of May 15, 1925, resulting in status epilepticus. We have already seen that epileptic seizures may be increased in number and severity by roentgen treatment of gliomas.

Unless the treatments cause unfavorable reactions, however, it is probably best to give these tumors a series of postoperative irradiations because of the possibility of malignant transformation.

F. SPONGIOBLASTOMA UNIPOLARE

These tumors, sometimes called neurinoma centrale, are indolent growths with a long clinical evolution and few signs of active growth. We have not submitted any such tumor to roentgen treatment, but Bremer, Coppez and Sluys[25] report a glioma of this type (No. 9 of their first report; Case 3 of the second report) treated without improvement.

G. EPENDYMOMAS

These are benign tumors which do damage mainly by blocking cerebrospinal fluid circulation since their favorite location is in the fourth ventricle, or sometimes near the other ventricles of the brain. Microscopically they show no signs of growth.

CASE 60. Surg. No. 15442. *Ependymoma of left temporal region. Osteoplastic operation with evacuation of cyst. Roentgen therapy, T. 293. Secondary operation four years later. Apparently well April, 192-.*

E. F. W., aged twenty-two, was admitted Oct. 24, 1921, complaining of headaches, vomiting and weakness of the right arm and leg, having been referred by Dr. J. Fred Clarke of Fairfield, Iowa. She had always been a frail, weak individual and had practically all the infectious diseases—measles, mumps, chicken pox, scarlet fever, malaria, typhoid fever and influenza—but was never seriously ill. In December, 1920, she began to have frontal headaches. In March, 1921, following a sore throat, she began to have headaches and pain in the right cheek. During the following two months she had very severe headaches and in April, 1921, difficulty in speaking. She had also about the same time difficulty in writing, and numbness in the right hand and leg. Since May, 1921, there had been some pronounced weakness of the right arm. In August, 1921, weakness of the right side of the face was noted. Aug. 12, 1921, she began to have excruciating headaches with vomiting. On Aug. 17 she was unconscious for eight hours, and the last few days she had been complaining of double vision.

On examination there was found bilateral choked discs of 5 D., left abducens palsy, right facial palsy, weakness of the right arm and leg, motor aphasia, agraphia and alexia, and a right homonymous lower quadrant defect in the visual fields. Roentgen examination showed an area of calcification just over the wing of the sphenoid in the left hemisphere.

On Nov. 1, 1921, Dr. Cushing turned down a bone flap over the left hemisphere and discovered a large cyst containing 150 c.c. of yellow clotting fluid. When the cyst was opened there was a tumor mass about 5 cm. in diameter in its base, which was dislodged without bleeding. The mass as lifted out measured 5 × 3 × 3 cm. The patient was restless and delirious the day following the operation, having apparently visual hallucinations, but after that she improved rapidly and on Nov. 12 her facial weakness had disappeared and she was talking

without difficulty. Her choked discs had subsided to about 2 D. She was discharged on Nov. 26, the fundi still showing some slight choking; hemiparesis having practically disappeared; speech and writing normal. The defect in visual fields had disappeared. She was given a roentgen-ray treatment on Nov. 25, of 300 ma-min., 130 kv., 12 in. distance, through 1.0 mm. copper. Treatments were continued by Dr. John Herrick of Ottumwa, Iowa, on Jan. 3, Jan. 5, Feb. 21, Feb. 23, Apr. 4, and Apr. 6, 1922, each 200 ma-min., 145 kv., 12 in. distance, through 0.5 mm. Cu and 1 mm. Al, all over the operative area. Her symptoms entirely disappeared and she was perfectly well until the birth of a boy on Aug. 7, 1924. About an hour after delivery she developed a right hemiparesis from which she recovered promptly, however, so that a few days afterward she seemed to be perfectly well. But in the latter part of September she began slowly to lose the use of her right arm and leg and began having headaches.

She was re-admitted to the hospital on March 23, 1925, Surg. No. 23483 and 23609. On admission, examination found the decompression left at the previous operation to be flat and under no tension. There was a right hemiparesis and hemihypesthesia, most marked in the right arm, which was almost completely paralyzed. The optic discs showed secondary atrophy but no choking. Slight aphasic symptoms were also present.

On Apr. 13, 1925, Dr. Cushing, under local anesthesia, did a secondary exploration. The cyst was reopened and over 100 c.c. of fluid evacuated. The cavity thus exposed seemed to fill a large part of the hemisphere. In the depth could be seen the thin wall of the lateral ventricle, which was not opened. In the lower temporal region of the cyst was a mass of tumor about 1 cm. in thickness and about 3 cm. in diameter. It peeled readily away from the brain tissue. The interior of the cyst was then fixed with formalin, and the wound closed.

The patient recovered promptly and was discharged on April 30, 1925, her condition being practically the same as on admission. April 1, 1927, her husband reported her condition to be unchanged.

Impression. The slow improvement which occurred during roentgen therapy was probably due to the residual effects of the operation.

CASE 61. Surg. No. 18049. *Ependymoblastoma of the fourth ventricle. Suboccipital exploration. Roentgen therapy, T. 4-6. Apparently well October, 1926.*

G. J. D., aged ten, was admitted Jan. 6, 1923, complaining of headache, vomiting and staggering gait, having been referred by the Children's Hospital, Boston. Six months before admission, having previously been well with the exception of an otitis media, he was noticed to have an occasional frontal headache. Soon afterwards he was pushed backward from a cart after which he had stiffness of the neck. Two days after this accident he vomited shortly after breakfast. Since then he had had these attacks of vomiting almost daily. He was taken to two different hospitals where a diagnosis of congenital psychopathic inferiority was made. For about a month and a half he noticed a weakness of the extremities and for a month he had been staggering with a tendency to fall backward. Three weeks before admission he complained of double vision.

On examination there was found bilateral choked discs of 6–7 D. elevation, nystagmus on looking to the right and left, very marked suboccipital tenderness, hypotonicity of all the extremities and marked incoördination of cerebellar type affecting all the extremities so that the patient was unable to stand and unable even to feed himself. Tendon reflexes were exaggerated throughout.

On Jan. 17, Dr. Horrax did a suboccipital exploration and disclosed a grayish red tumor occupying the spaces between the two cerebellar hemispheres, the apex of the tumor running down through the foramen magnum and into the spinal canal. Although the arch of the atlas was removed and the dura opened down to the second cervical vertebra, it was not possible to see the lower extremity of the tumor. The tumor was easily separated from the cerebellum and apparently had no connection with it, but seemed to be firmly attached to the 4th ventricle so that any interference with the tumor caused a drop in blood pressure and disturbance of respiration. A few fragments of the tumor were removed for microscopic examination and the wound was closed. The patient recovered promptly; his discs subsided rapidly. On Feb. 7 roentgen-ray treatment was given, 125 ma-min., technique "A." By Feb. 10 he was able to get about the ward by himself; was eating well, and getting stronger every day. His optic discs were flat. Although he still had very marked incoördination of all his extremities and a nystagmus on looking to right and left, the change in his condition was quite striking. Roentgen treatments were continued Mar. 1, 125 ma-min., Mar. 22, and Apr. 11, 1923, 150 ma-min. On May 23, 1923, with the exception of occasional vomiting on arising in the morning, he had been perfectly well. His fundi were flat; he had no nystagmus.

There was hypotonicity of all his extremities and very little incoördination. His gait was normal and he was able to walk a line or to maintain his equilibrium on either foot alone. Roentgen treatments were continued June 7, 125 ma-min., and June 28, 150 ma-min. On Feb. 21, 1925, he was quite well; had no symptoms whatever except hypotonicity; had been going to school regularly, and had not even been vomiting. Oct. 16, 1926, examined and found to be in perfect health.

Impression. The improvement which occurred slowly under roentgen therapy was probably due to the residual effects of the operation.

CASE 62. Surg. No. 24953. *Ependymoblastoma of fourth ventricle. Suboccipital operation. Partial extirpation. Roentgen therapy No. 1139. Much improved in June, 1927.*

On Oct. 8, 1925, there was admitted to the hospital Lillian M. O., aged thirty-six, referred by Dr. G. M. T. Hazen of Saskatoon, Saskatchewan, and complaining of headache, vomiting, double vision and unsteadiness of gait.

She had always been frail and suffered from a series of infectious illnesses of various kinds, but was fairly well in 1923 when she began to notice that she stumbled in the dark, and occasionally she had attacks of dizziness. In May, 1925, morning vomiting set in and continued regularly. In August, headaches began in the occipital region, and her gait became very unsteady. Recently she was troubled by double vision and failing memory.

There was found on examination bilateral choked discs of 4–5 D. elevation, nystagmus on looking to right and left, hypotonicity and ataxia especially of the left arm and leg, and staggering gait.

On Oct. 14, 1925, a suboccipital operation was done. When the dura was opened no tumor was seen but incision of the vermis disclosed a grayish tumor completely filling the fourth ventricle and blocking the circulation of cerebrospinal fluid. Sufficient of the tumor was removed to allow the fluid to escape freely.

Course of Illness. The choking of the optic discs subsided promptly but she continued to be dizzy and vomited when she tried to sit up or stand. On Nov. 5, 1925, she was given a roentgen-ray treatment of 150 ma-min., technique "A," over the cerebellar region. She was discharged on Nov. 7, 1927, with headaches and choked discs relieved but still ataxia and vomiting on arising in the morning.

She was given 6 roentgen treatments by Dr. E. E. Sheply of Saskatoon according to our technique and at three-week intervals. On June 28, 1927, Dr. Hazen reported that she was having no nausea or vomiting and only occasional dizziness and diplopia when tired. Very slight unsteadiness of gait also persists.

Impression. It is quite probable that the same improvement would have occurred without roentgen-ray treatment. (Compare Case 1 of Bailey's original study[26] of the ependymomas.)

SUMMARY

In no case of this group was there any immediate benefit from irradiation. It cannot be claimed either that their long survival is due to irradiation. There is one patient in the records of the clinic with a tumor probably identical with that of Case 61 who is living and well twelve years after a simple suboccipital decompression.

SUMMARY OF RESULTS

When the foregoing experiences are considered in the light of a knowledge of the behavior of the different types of tumors involved, it is evident that roentgen therapy exercises a restraining influence upon those gliomas composed of rapidly dividing embryonic cells, notably the medulloblastoma and to a less extent the spongioblastoma multiforme. Its influence upon the latter is often terminated by hemorrhages into the tumor, possibly due to the effect of the irradiation upon the numerous abnormal and degenerated blood vessels so common in this type of glioma. Some improvement has also been obtained with the protoplasmic astrocytoma, possibly also with the astroblastomas. Of the more slowly growing gliomas, it is not apparent from our experience that the oligodendroglioma, ependymoma and the fibrillary astrocytoma are influenced favorably by roentgen therapy.

These results are in accord with the theroretical conclusions of Ewing,[14] based on the law of Bergonié and Tribondeau, the gliosarcoma and neuroepithelioma to which he referred being considered to correspond respectively to what we have called spongioblastoma multiforme and medulloblastoma.

CONCLUSIONS

1. Roentgen therapy of intracranial gliomas should be undertaken only after

an attempt has been made to extirpate the tumor when localized, or after a decompression has been done in case the tumor cannot be localized.

2. Roentgen therapy will not cure any glioma, but exercises a restraining influence upon the growth of the most rapidly developing types, notably the medulloblastoma and the spongioblastoma multiforme, possibly also the astroblastoma and the protoplasmic astrocytoma.

3. It is probably wise to give a series of treatments postoperatively even in cases of benign gliomas, with the exception of the fibrillary astrocytoma and the ependymoma, for some of them, notably the protoplasmic astrocytoma, possibly also the oligodendroglioma and the astroblastoma, have a tendency to increase in malignancy after operative interferences.

4. The variable effects of roentgen therapy upon the clinical symptoms produced by brain tumors of the same histological structure, are probably due to the fact that the symptoms are in part, often *in toto*, caused by blockage of the circulation of the cerebrospinal fluid, cystic degeneration and hemorrhage into the tumor, and not by rapidity of growth.

5. Roentgen therapy in any case of intracranial tumor must be given with the utmost caution for it may result in headache, vomiting, delirium, coma and even in death of the patient.

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DISCUSSION

Dr. K. G. McKenzie, Toronto. My discussion of this excellent paper must be from the surgeon's standpoint. Neurological surgery at the best becomes extremely discouraging at times and any new strings to our bow are very warmly welcomed. The authors are to be congratulated on the excellent work they have done on this line. At the same time it seems to me that it is well to remember the man who made the work possible, and that is Dr. Cushing. Any of us who have attempted to keep records and specimens must marvel at

and fully appreciate a man who will keep perfect records over a long period of years and at the same time preserve perfect specimens over a period of twenty years available for study, as Dr. Cushing has done. In the keeping of these records and specimens he has made this work possible.

The authors have pointed out how these gliomata are extremely variable, running from the embryonic type of cell through the highly differentiated type and have pointed out, just as you would expect, that it is in the embryonic type of tumor that the best roentgen-ray results are obtained. Dr. Sosman also emphasized that it is in this very type of tumor—this embryonic type—that as surgeons we feel so helpless about, that they get their best results with roentgen therapy. We doubly welcome that statement because we feel that from the surgical standpoint we are helpless.

He emphasized the necessity of surgical intervention before roentgen treatment. There are several reasons for this. One is that no matter what the pre-operative pathological diagnosis may be, one may come down on a lesion which is amenable to radical surgical treatment. Secondly, at operation one is enabled to make an accurate, or hopes to make, a more accurate localization and an accurate histological diagnosis. In that way one can estimate what the outlook is likely to be. Then thirdly, and perhaps most important from the roentgen standpoint, is the fact that after having surgically explored one of these lesions, one almost invariably leaves a decompression and it is this decompression that makes for safe roentgen therapy; that is, you have a safety valve which will take care of a reactionary edema or even hemorrhage into a tumor.

In Toronto it is our practice to handle these lesions somewhat as follows: Apart from the pituitary cases, we believe that all brain tumor cases should first have surgical intervention, and in a certain percentage of cases we are able to remove a tumor or accomplish a good deal. We make an accurate localization and we attempt then to get a bit of tissue, if possible, and make an accurate histological diagnosis. In that way we are gradually building up a series of cases, true, very small—at the present time we only have 12 verified gliomas which are being treated by roentgen therapy—and these cases have occurred over a period of three years and we are not in a position to say whether roentgen treatment has been of benefit or not.

In conclusion, I should like to branch off just for a moment and say a word or two about pituitary lesions. We feel that the pituitary problem is something apart. Here a diagnosis can be made with the aid of the clinical and the roentgen examination, as to whether a lesion is a pituitary adenoma or a cyst. If the case is a cyst, roentgen treatment is of no value, but if it is an adenoma we believe firmly that roentgen treatment should be carried out in almost every case, unless there is a real emergency in the saving of vision.

Dr. H. K. Pancoast, Philadelphia. In order to accomplish anything whatever in the treatment of brain tumors, we must have very close co-operation between the neurological surgeon and the roentgenologist, just as is carried out by Dr. Sosman, Dr. Cushing and Dr. Bailey.

Up to 1926 we had treated some 90-odd cases of tumors exclusive of pituitary cases, and since then quite a number have been added, but those form the basis of our recent report. Our report distinctly stated that we were very much disappointed in the effect of irradiation on brain tumors, with a few exceptions.

It is always desirable that the case should be operated upon before irradiation is practiced. This is not always possible. We have treated a number of cases in which it was not done because the tumor could not be localized or it was not found at operation, but I might say that methods of localization of tumors through the aid of the roentgen ray are very much more accurate now than they were a year or a few years ago, so that most of them can be localized at the present time, with the addition of the help of the ventriculogram or the encephalogram.

There are several reasons why operation is desirable. Of course, first, for the exact localization of the tumor. Secondly, to determine the nature of the tumor, to see whether it is one which is radiosensitive or not. Thirdly, the reason which has been mentioned by Dr. McKenzie, namely, to get the effect of decompression. We must realize that the improvement in a great many cases, which is immediate or may last for some weeks or months following the operation and during which we may be treating the case, may be partly or entirely due to the operation itself. It is sometimes ascribed to the radiation treatment, but, as has been said, it always gives a safety valve for pressure which is likely to result from the irradiation.

The dangers have been stressed by Dr. Sosman. Our early cases in 1923, treated by deep roentgen therapy, gave us a great deal of alarm because we were using not the fractional dose method but a modification of it. We gradually reduced the time period of each daily dose to about one-fifth to one-seventh of the skin dose over one area, and since we have been doing that we have not been alarmed in any

case by untoward symptoms. But when we treated with larger doses in one day, we frequently had a great deal of anxiety, and I believe that the use of larger doses than the fractional dosage is a great mistake for this reason.

We have measured the skulls recently in all our cases in order to introduce as large a dose as possible into any given locality within the head, and we have finally selected three ports of entry in most cases in order to deliver 100 per cent, even including the cerebellar ones. We have given up the single areas posteriorly because we found such a small dose reached the single site, but in order to get at more of the larger tumors we have introduced more than a skin dose into that tumor site in order to accomplish more than we have been doing in the past. When I say 100 per cent, that is not 100 per cent actually because it is spread over a considerable period of time. We have not gone so far as to use the saturation dose but we are on the verge of carrying it out at the present time. In the cerebellar lesions we were able to get by measurements, by means of three ports of entry, 100 per cent of the skin dose, and we have not found that there has been any danger in doing this so far.

I just wanted to call attention to one other point in regard to the use of radium implantation, which is being done in some places. We have not used it for a number of years but it is possible that we may adopt it yet, if we find that some tumors may require 100 per cent, or nearly 100 per cent skin dose to influence them at all. Of course, if they require more than that there is no use of trying to get any results because we can't do it, but suppose it is possible that a tumor may respond to a little less than 100 per cent of a skin dose, we may not be able to get 100 per cent into all portions of that tumor through external irradiation alone; it may be possible (of course, this is more or less theoretical) to use implantations in such cases. A word of warning about them: Never use implantations if a tumor has been completely removed; that is very dangerous, as has been proven by our experiments; implantations of radium into normal brain tissue is dangerous. Also be sure that the tumor is where you think it is, before you put in radium implantations, because we are pretty sure that death has occurred from the implantation of the radium into the brain tissue which was supposedly the seat of a tumor, but the tumor was found to be elsewhere. It is possible to apply radium implantation if you build up your external dose. This just proves that each dose is a law unto itself; the size and extent of the tumor must be carefully studied and your procedure must be studied beforehand, before you begin and you must not treat these cases in a haphazard manner.

Dr. Charles L. Martin, Dallas, Texas. We have had in Dallas, up to the present time, about 12 cases of brain tumor that we have treated with deep therapy. I would not arise to discuss that brief group except that our experience has not been quite that of the men who have spoken today. In the first place, we have used extremely intensive treatment. Dr. Desjardins is using the same method at the Mayo Clinic. We have been giving just as much roentgen radiation as we could give, using deep therapy, dividing the head into four quadrants equally and administering the dose to each quarter, somewhat in the manner that the epilation dose is laid out. We have not given it in any case that did not have a trephine. I should like to have Dr. Sosman, in closing, say positively whether he feels that immediate reaction is dangerous after trephine.

We give each of these quadrants a full erythema dose for four days, and I have repeated that as many as three times on patients, at six-week intervals. I must say the reaction is very slight. It is true that usually we give those patients large doses of chloral hydrate before administering each dose. The trephine openings are small. We did injections of the cerebral ventricles with air on two of these cases before the treatment was given and that much trephine apparently was sufficient. One of these patients I remember particularly was a little girl to whom we were afraid to give this treatment but we gave it and had no reaction whatever.

In the physiological laboratory, we attempted to study this in dogs after giving them large doses. The dogs continued to eat well and had no reaction whatever. If Dr. Sosman can give us any information on this particular point, I should appreciate it.

The other question he raised in the treatment was the danger of hemorrhage. I should like to ask him to say whether he can prove that hemorrhage in the treatment of these brain tumors is due to the roentgen treatment. I can see how we might have hemorrhage three or four months afterwards but I see no reason to expect it as an immediate result of treatment.

Dr. A. U. Desjardins, Rochester, Minn. At the Mayo Clinic we also have treated a large number of gliomas and other tumors of the cerebrum and cerebellum. These are always treated in very close co-operation with the neurological clinicians and surgeons. We have not yet analyzed the final results in the different elements in that group and consequently I am not certain how our results will compare

with those of Dr. Sosman and Dr. Bailey. My general impression is that the results are approximately the same.

The only thing I want to bring up is in connection with these accidents. It is true that many cases develop headache soon after treatment and sometimes if the treatment has been very heavy the headache may be quite distressing, but as far as the other accidents, such as the reaction, and so forth, are concerned, we see very little of it. We have had several patients die after treatment, and in every case we found some surgical complication; that is, some complication attributable to the operation itself and not at all to the roentgen treatment. We have watched each case very closely and when some of them died we were very careful to investigate that point, and we have not yet been able to find a definite complication attributable to the roentgen treatment.

Dr. Sosman (closing). I should like to thank Dr. Pancoast for his excellent discussion and also Dr. McKenzie for his. I am sure the few exceptions in Dr. Pancoast's series are probably one of these first two groups, either the medulloblastomas or the spongioblastomas. They give very good immediate results, but unfortunately they are like the lymphosarcomas, they recur.

So far as I know, we have not cured any case of brain tumor by roentgen radiation up to the present time, but we have very definitely alleviated the condition and relieved many of the patients.

As to the trephine, I do not believe the dose is dangerous with plenty of room for the brain or the tumor to expand, but we frequently get reactions in these cases with a decompression. The decompression will protrude within twelve to twenty-four hours after treatment and the patient may be in very poor condition twenty-four hours after treatment and then gradually improve. It is very common to see that in our patients.

As to Dr. Martin's experiments with dogs, that can be explained by the fact that it is very difficult to get any edema in the normal brain with roentgen rays or radium, but the tumor reacts very quickly and gives very definite swelling. The symptoms are due to the locations of the tumors; that is, the particular parts of the brain which the tumor affects. In the second place, the symptoms are due to the decompression. That is entirely nonspecific. In the latter instance a very small tumor in the fourth ventricle (the ependymoma) kills the patients almost entirely by blocking off the cerebral circulation. It is an extremely benign tumor and there is no use of treating that with roentgen rays. If you can remove that completely, you can relieve your patients, because it kills the patient purely by mechanical action. That will explain I think, Dr. Martin, why you have this freedom of reaction in your patients.

The question as to causing hemorrhage by roentgen ray: The second group, the spongioblastomas, are liable to hemorrhage anyway and it was our impression that the added insult of the treatment might easily cause a hemorrhage which would not have happened otherwise.

Vol. XIX, No. 3

RADIUM TREATMENT OF CAVERNOUS HEMANGIOMAS AND OF EPULIS*

BY A. STRAUSS, M.D.

CLEVELAND, OHIO

IT was my intention to offer a word of apology for presenting a paper on the treatment of such simple conditions before a body so seriously concerned with the treatment of cancer. But now I find myself in the midst of a symposium on the treatment of hemangiomas. I wish to discuss these conditions because they are simple and the treatments are likewise simple, and I feel that it may help to establish this method and do away with older more destructive and more complicated methods still in use. "Angioma is a tumor of newly formed vessels." Unlike other tumors these are influenced by the mechanical pressure of the circulation.

I shall not speak of the nevus venosus except to note that it may be the source of a cavernous hemangioma. Ribbert's work tends to show that angiomas grow by budding and sending vessels out into the surrounding tissue. Others believe some angiomas are due to simple hypertrophy of vessels. Ewing points out that the fact that most are congenital speaks in favor of a tissue predisposition. These hemangiomas have very little supporting structure. This is important because that means there is no fibrous tissue to be increased by proliferation from radiation, nor can scar tissue be relied upon to cause an obliteration of the vessels.

Those to be reported here involved the skin and subcutaneous tissue. However, 2 cases of cavernous hemangioma of the liver were treated. In these no result was reached. Death occurred in both and no autopsy was obtained. The effect of radiation on blood vessels has been well shown in roentgen-ray dermatitis. Here hand in hand with the subcutaneous fibrosis a marked proliferation of the intima occurs until the lumen is occluded. Some vessels undergo hyalinization. But in this lesion there is a very different condition from hemangiomas due to the fact that these small vessels have thick walls and are well supported by connective tissue. In the cavernous hemangiomas the walls are thin and they have very little or no supporting tissue. It is well known that disease may cause such changes in the walls of vessels that the lumen will be nearly obliterated. This occurs in syphilis, diabetes, thromboangiitis, and endarteritis.

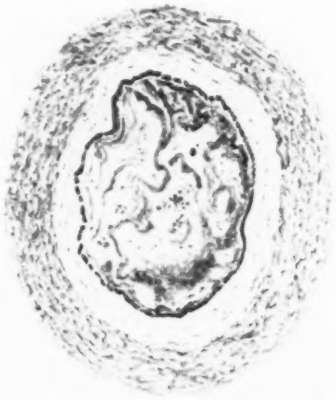

FIG. 1. Showing necrosis of intima and thrombosis (after Dobrovolskaia-Zavadskaia).

FIG. 2. Arteriole in zone of atrophy. Parietal thrombus and disappearance of endothelium (after Dobrovolskaia-Zavadskaia).

* Read at the Twelfth Annual Meeting, AMERICAN RADIUM SOCIETY, Washington, D. C., May 16–17, 1927.

Thus it is the aim of the therapist to induce by radium treatments what nature or disease can bring about in the arteries and veins.

Dobrovolskaia-Zavadskaia, by placing radium along blood vessels, was able to

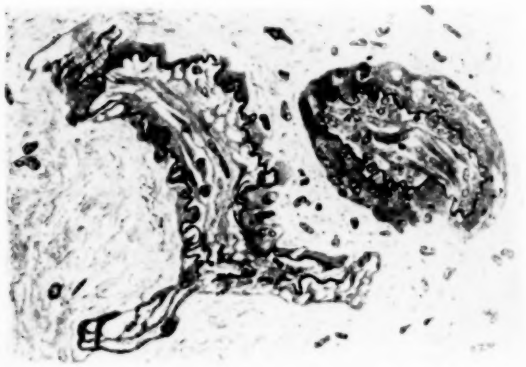

Fig. 3. Proliferation of interna going on to obliteration of the lumen (after Dobrovolskaia-Zavadskaia).

produce proliferation of the intima by gamma radiation as shown in Figures 1, 2 and 3. She noted that beta and soft gamma rays cause a zone of necrosis and that the hard gamma rays cause a zone of atrophy. These zones do not follow the

Fig. 4. Case A. Aged two months. Hemangioma of the eyelid. Tumor 1 cm. in diameter. 7.26.21 four 12.5 mg. needles, contact 35 min.; 9.14.21, 100 mg. in 0.5 mm. silver, contact 10 min.

course of the vessels, but extend concentrically from the radium focus. In the zone of necrosis the capillaries disappear, circulation is stopped by thrombosis and all repair originates in the periphery of the zone by migration of cells. This is not a condition to be desired in treating hemangiomas because it is probable that the vigorous attempt at repair made by the connective tissue after necrosis is the cause of the telangiectases that appear in the scar.

On the other hand, in the zone of atrophy the changes affect the arteries and veins alike, and appear either in one or all coats. The effect of radiation is seen in the swelling and desquamation of endothelium and its tendency to proliferation, even to plaque formation and obliteration of the lumen, in atrophic changes in the elastic fibers, and vacuolization of cells in the media.

If we can produce this condition in treating cavernous hemangiomas we shall obtain complete shrinkage of the tumor without scar formation except what must result from atrophy of the overlying skin already affected by the tumor. This should be easier to obtain than in the above experiments because it is easier to reach the intima through the thinner vessel walls.

Of course in the treatment of this lesion by radium I have no specimens to show and I was unable to make any microscopic study. But I can show what the lesions

Fig. 5. Case A. After treatment. Aged two and a half years.

looked like before and after treatment, and thus reason from analogy as to what took place in the vessel walls.

The technique I have used, I feel, approaches the conditions of the experiments cited above and the results may be

assumed to have been accomplished by a similar process.

I employed uncovered 12.5 mg. radium needles or radium in a 0.5 mm. silver capsule, the former in contact with the surface of the lesion and the latter but 1 cm. removed. This method removed about 85 per cent of the hard beta radiation. As with other therapists the treatments were given four to eight weeks apart. I have never been in a hurry. I have found that the younger the patient, the more susceptible the lesion is to radiation and therefore the smaller the dose and the better the result. If all cases were treated in the first year of life, there would not be the large extensive hemangiomas that are difficult to treat with radium or surgery now seen in adults.

Wickham and Degrais in 1912 were the first to report hemangiomas treated with radium. Since then there have been many reports of good results but the technique for the most part was well filtered rays, or insertions of radium needles.

My cases include 22 children of whom 11 were in the first six months of life and 8 in the second six months. The other 3 were seventeen months, five years, and five years of age respectively.

There were 2 cases which were not treated by the routine mentioned. One, six weeks old, was the youngest case in this series, who had an hemangioma of the eyelid, extending to the retrobulbar space. On account of its deep location this case was treated with packs from May 25 to December 22, 1925, three times in seven months with a good result. The other child was six months old, and had a lesion on the big toe. A good result was obtained with three treatments in ten months using unfiltered emanation capsules in the form of a plaque.

Fig. 6. Case B. Hemangioma of the neck. (Taken after tumor had begun to recede.)

Fig. 7. Case B. After treatment.

The hemangiomas in the remaining cases occurred as follows: on the scalp, 4; eyelids, 3; forehead, 4; nose, 3; lip, cheek, ear and neck, forearm, thumb, vulva and back each one. Two of the 4 scalp cases were situated immediately over the anterior fontanelle.

One tumor situated on the eyelid was treated when the baby was two months old and received two treatments. The lesion disappeared without the loss of an eyelash (Figs. 4 and 5).

The baby with the growth on the left vulva was in such distress that she was losing weight, was irritable and sleepless. This was due to the fact that being wet continuously, an ulcer had occurred on the surface of the angioma and this was sore and bled easily. This baby was four months of age and required two treatments.

Another baby aged six months had a tumor extending from the lower portion of the auricle of the left ear downward in the neck. It was spherical, measured $1\frac{1}{2}$ inches in diameter, pushed the lobule of the ear upward, and forward. The skin was not discolored, except in the ear where it had the usual red color. This child was treated seven times from September 2, 1924, to June, 1925, with the above technique supplemented by radium packs. The result is exceptionally good. The skin raised about 4 mm. This baby was first treated at the age of four months by a half strength radium plaque at two sittings before I saw her, and with some improvement. From July 31, 1925, to date she has had ten treatments, consisting of 12 mg. needles or 100 mg. capsule in 0.5 mm. silver in contact with the lesion. This case is still under treatment.

Among the other interesting cases of hemangioma were 2 that covered the end of the nose and involved the septum (Figs.

FIG. 8. Case c. Hemangioma of the nose involving septum. Aged six months. 6.5.24—3 portals: (1) 60 mg. in 5 needles, contact 10 min.; (2) same; (3) 35 mg. in 3 needles, contact 3 min. 7.22.24—3 portals: (1) 60 mg. in 5 needles, contact 10 min.; (2) 35 mg. in 3 needles, contact 5 min.; (3) 35 mg. in 3 needles, contact 3 min. 9.10.24—60 mg. in 5 needles, 10 min.; 50 mg. in 4 needles to septum, 10 min. 11.11.24—Treatment of septum repeated.

over the tumor is soft, pliable, wrinkly without telangiectasis. All that remains of the tumor is a deep freely movable piece of scar tissue about the size of a pea. A coincident effect is the atrophy of the tonsil on the same side (Figs. 6 and 7).

The most extensive case treated was a seventeen months old baby having a hemangioma involving the forehead, eyelids, and upper side of face on the left side. It measured 4.4×2 cm. and was

FIG. 9. Case c. After treatment.

8 and 9). These also cleared without telangiectases. This series, though small, is varied enough to demonstrate: (1) that the treatment of cavernous hemangiomas is simple with radium, without any other physical agent to supplement the radium; (2) that it can be applied to an infant, with better results than in older patients; (3) that soft gamma and some beta radiation is compatible with a good result, and finally, I would like to emphasize the good result obtained by immediate radium treatment of an ulcerated hemangioma.[1]

EPULIS

Epulis, according to Scudder, is a topographical term. Microscopically it is a periosteal giant cell sarcoma of the alveolar border of the jaw. It is characterized by

[1] For bibliography see paper on Radium Treatment of Haemangiomata, Lymphangiomata and Naevi Pigmentosi. G. Andren. *Acta radiol.*, 1927, viii, 1–45.

its low grade of malignancy, by its tendency to recur, and by its not having a tendency to metastasize, and histologically by the osteoclast type of giant cell in a rich fibrillar network usually of spindle cells. They vary considerably in their vascularity. The more fibrous types are less common, are less malignant, have less rapid growth, and may be cured sometimes by excision and cauterization of the base. They are pale and firm, while the more vascular are reddish and softer and resemble granulation tissue from which they must be distinguished, especially when they occur about a decayed tooth or root. The more vascular types are apt to have more giant cells.

They occur in childhood and young adult life, and more frequently in the female than in the male. Epulis is usually situated near the canine, bicuspids or first molar teeth, rarely at the incisors and almost never behind the last molar. Irritation from carious teeth or the like, seems to be an etiological factor, but epulis may develop next to a normal tooth. They grow very slowly and may attain great size.

Formerly these growths were regarded as purely a surgical condition. No treatment but operation was indicated. That meant that the tooth before and after the growth must be removed and the alveolar border of the jaw taken with it. If this occurred in a young child, the unerupted teeth were sacrificed as well or they grew out of alignment. Therefore, these operations were destructive if not deforming. Then, too, it has not been unusual to operate more than once on one of these patients. Wassermann at the Heidelberg clinic reported 3 recurrences in 18 cases; Gunzert, 3 in 35 cases, with one metastasis; Bloodgood and Scudder report no metastases in their cases of 40 and 19 respectively, but both saw recurrences.

Fig. 10. Case D. Epulis, six years after treatment. Scar to right of chin from necrosis of jaw.

Fig. 11. Case D. Showing space between teeth. Healed six years.

I have 4 cases of epulis to present. The first case treated was six years old in 1920. Previous to this, the tumor had been curetted once, excised and cauterized once, and the last time I myself had excised it with the alveolar border on April 26, 1919. On November 11, 1920, I began radium treatments to the recurrence and by January 27, 1921, I had given this tumor a total of 235 mg-hr. without checking it.

On April 2, 1921, it was found that the tumor had surrounded the unerupted teeth and four needles were inserted into the mass and left for a dosage of 1150 mg-hr. This treatment destroyed the tumor so that it has not recurred, but, with the already thinned mandible, proved to be

too strong a dose. A pathological fracture occurred with a necrosis of the jaw. A sequestrum was later removed, the jaw was held in position by a wire splint and recovery ensued. Thus, this patient who had three recurrences between 1917 and 1920 following surgical treatment has remained free from recurrence for six years following irradiation (Figs. 10 and 11).

5 mg. needles were inserted from the outer edge to the base, and left until 230 mg-hr. were given (Figs. 12 and 13). In the second, a woman, aged thirty-four, the epulis grew over the two bicuspids on the left. She received the same treatment for 240 mg-hr.

The third case was a man, aged thirty-five, with an epulis between the lateral

Fig. 12. Case E. Epulis; four months' duration. Treatment, four 5 mg. radium needles; 230 mg-hr.

Fig. 13. Case E. Epulis after treatment. Healed two and a half years.

After this successful though unfortunate result it was decided to treat the next cases by imbedding radium needles first and keeping the dose very small. The next 3 cases were not operated upon. The diagnoses have been clinical ones. No sections were taken.

The cases were treated as follows. The boy, aged nine, had a tumor measuring 1.5 cm. in diameter originating between the right lateral incisor and the canine. Four

incisor and canine on the lower jaw. This was definitely of the fibrous type, firm and rather white, and of three years' duration. The treatment in this case consisted of three needles, 5 mg. each, for twelve hours, 180 mg-hr. These cases have remained well two and a half years, two years, and one year respectively. Slight retraction of the gum resulted in all three, but the teeth were saved.*

* For discussion of this paper see page 274.

Vol. XIX, No. 3

THE TREATMENT OF CAVERNOUS ANGIOMAS COVERED WITH HEALTHY SKIN*

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THE treatment of angiomas has always been of great interest to physicians, as evidenced by the many methods that have been advocated in the past with more or less success. Unfortunately, angiomas frequently occur upon the face, or other exposed parts of the body, and are a source of disfigurement as well as a danger, due to frequent accidental bleeding and ulceration, and in later life, the possibility of malignant degeneration. Occasionally, they have been known to undergo spontaneous disappearance, but the vast majority persists, and although small in the beginning, frequently increase in size and become so great an annoyance to the patient that their removal is required. Angiomas may be placed in one of three classes:

(1) *The port wine mark*, or *nevus flammeus*. Radium has been used in the treatment of this condition with varying success. It is almost impossible to secure a uniform fading of the mark, and frequently, scarring and other unpleasant complications develop, so that radium is not recommended in this type of angioma. The use of the ultraviolet light by the compression method gives a uniform fading, and when used with a proper technique over a sufficient length of time, will produce as nearly ideal results as can be expected.

(2) *Nevus vasculosus*, or *strawberry mark*, consists of larger vessels than the port wine mark, and is always elevated above the skin. These cases frequently respond very satisfactorily to radium. Great care must be exercised to use the proper dose, and as a rule, it requires from three to ten treatments over a period of months in order to entirely eradicate one of these lesions, but the results are usually very good. The use of electrothermic methods in this particular type of angioma offers advantages, especially in certain locations. The angioma may be destroyed instantly without the loss of blood, and healing takes place in three or four weeks with entire eradication of the lesion. In infants, they can be treated within the first few days after birth, without anesthesia, and by thus destroying the lesion when small, future difficulties will be prevented. The electrothermic method is better than radium, as it is more certain and rapid. Angiomas in certain locations, such as the lip, where treatments might interfere with feeding, are probably better treated with radium.

(3) *Nevus cavernosus*, or *cavernous angioma*. In this condition, the deep vessels, particularly the veins, are enlarged, and the growth is usually situated in the depths of the tissue, varying in size from a pea, to the size of a dollar or more. Many of these cases are covered with a healthy normal skin, others present a small area on the surface showing discoloration, and enlarged elevated vessels. These cavernous angiomas may involve the entire thickness of the cheek, and produce marked deformity and interference with the function of the mouth. Many forms of treatment have been attempted for this condition, among which may be mentioned the injection of boiling water, electrolysis, and the use of radium and roentgen rays.

The very profound effect which radium has upon the vasular structures suggests its great value in the treatment of angioma. Investigation shows that the beta rays of radium are by far the most effective, and to a lesser extent, the gamma rays, in producing those vascular changes.

The changes which take place in a blood vessel, under the influence of radium treatment, have been described by Wolbach (quoted by MacKee) as follows:

"The obliterative changes in the veins and arteries are manifested chiefly in a great increase of connective tissue beneath the endothelium, and in marked thickening of the media. In the arteries, there is the disappearance of the elastic lamina and a substitution of

* Read at the Twelfth Annual Meeting, American Radium Society, Washington, D. C., May 16–17, 1927.

a thick, irregular band of hyaline collagenous material. The thickened intima is composed of connective tissue with much collagenous intercellular substance. The endothelium is often composed of swollen and vacuolated cells which occasionally form tufts of cells projecting into the lumen.'"

The radium treatment of cavernous angiomas covered with healthy skin has been rather uncertain in its result, and very time consuming. The problem is to produce a sufficient effect upon the vessels of the angioma without damaging the skin, and possibly rendering the condition more unsightly than before. This means surface irradiation so regulated as not to produce a skin reaction. This treatment requires repetition once a month, over a period of a year or more, in order to cause the disappearance of the angioma. Even under the best conditions, repeated doses of this kind must necessarily have some devitalizing effect upon the normal skin covering the growth. It was with a view of overcoming these difficulties, and of shortening very materially the time of treatment, that a different procedure was attempted. The beta rays are more valuable in producing the destruction of blood vessels, the effect of which is practically lost with the surface applications. It was thought that possibly the use of buried radium element in suitable needles would accomplish the results desired. We have had experience in 3 cases of quite large angiomas of this character, with very excellent results, and without any undesirable effects. In those cavernous angiomas which show some area of nevus vasculosus, the method is also of value, and equally good results are obtained.

The technique was as follows: Depending entirely upon the size of the lesion, steel needles containing 5 to 10 mg. of radium element were used. In the large lesions involving the entire thickness of the cheek, 10 mg. needles were used. In the more superficial angiomas, involving the upper lip, 5 mg. needles were employed. The needles together with the silk threads were thoroughly sterilized by boiling, after which they were immersed in an alcohol solution for half an hour.

FIG. 1a. M. P. A large cavernous angioma involving the entire cheek. (Case of Dr. W. L. Clark.)

FIG. 1b. Result of one treatment with buried radium in needles.

Local anesthesia may be used in patients old enough to co-operate, and a drop or two of a 2 per cent novocain solution at the site of each needle puncture is all that is necessary. In younger children, a light anesthesia with ether is preferable, so that we may have perfect control of the patient at all times. The needles must be uniformly distributed throughout the angiomas, and placed about 1 or $1\frac{1}{2}$ inches apart. Great care must be taken to plunge the needle only through the healthy skin, and never

through the tissue, which is the site of a nevus vasculosus. For this purpose, a sharp trocar is used to make the initial opening, after which the needle is passed through into the depths of the angioma and buried well under the skin. No bleeding was encountered in any of these cases, as the normal skin promptly contracts around the thread and prevents bleeding. The needles were left *in situ* for twelve hours, after which time they were withdrawn by means of the silk threads. The healthy tissue skin covering the angioma showed no evidence of any change whatever, and was perfectly normal in appearance. In one case in which a cavernous angioma showed a small area of nevus vasculosus, the surface nevus also disappeared with the other.

The following brief histories of 3 cases are reported:

CASE REPORTS

CASE 1. M. P., aged thirty treated, for Dr. W. L. Clark. Patient had a large angioma

FIG. 2*a*. S. S. Aged four months. Large cavernous angioma, covered with healthy skin, involving the entire cheek. (Case of Dr. W. L. Clark.)

FIG. 2*b*. The result of one treatment with buried radium element in needles.

promptly contracted around the needle holes, and only a drop or two of blood was lost. The reaction following this treatment was fairly well marked. The part became swollen, tense and hard with some slight ache or pain. This reaction persisted for two or three days, after which time it gradually subsided and disappeared entirely. The induration was the last to disappear, the parts having a more or less hard feeling for a period of two weeks or more.

The effects upon the angioma were very profound. Within a week it began to shrink, which shrinkage continued over a period of four to six weeks, and it gradually returned to practically a normal condition with the entire disappearance of the angioma. The

of the left cheek, present since birth. There had been very little change in size for years. The angioma involved the left cheek, beginning at the corner of the mouth, and was about 3 inches in diameter, involving the entire thickness of the cheek. The mucous membrane showed a bluish discoloration, but there were no elevated blood vessels. The patient was treated first on October 21, 1919, by external irradiation, 50 mg. of radium being applied over different areas for a period of twelve hours. Treatments were given every month for several months without any effect upon the tumor. It was then decided to attempt the introduction of radium needles into the tumor. On August 11, 1920, five radium needles of 10 mg. each were inserted into the angioma, and allowed to remain for twelve hours. This was followed by a marked reaction, the face becoming swollen, tense and somewhat

painful. Reaction subsided promptly in two or three days, and the induration disappeared after a period of about four weeks. There was a gradual, but steady decrease in size of the tumor. The patient had a nevus vasculosus around the eyelid and also around the lips, which were treated subsequently by external irradiation, with very good results.

CASE II. Ella S., aged four months, treated for Dr. W. L. Clark, was born with a large angioma involving the right cheek. The entire thickness of the cheek was involved, and

FIG. 3*a*. M. N. W. Cavernous angioma involving the entire upper lip with several areas of nevus vasculosus on surface. (Referred by Dr. A. Garvey.)

the growth extended from the corner of the mouth back to the angle of the jaw, about 3 inches in diameter, and elevated above the surface about 1½ inches. It was covered with a healthy skin, and with no surface evidence of angioma. An attempt was made to treat this case by external irradiation on June 8, and again on August 17, 1920, without any effect on the size of the tumor. It was then decided to treat the case by the implantation of radium needles. On March 1, 1921, ten radium needles of 10 mg. each were inserted into the tumor for a period of twelve hours. This was followed by marked reaction, swelling, infiltration and marked soreness. The inflammatory reaction subsided after three days, and there was a gradual regression of the tumor until it practically disappeared.

CASE III. L. M., aged two years, born with an angioma of the upper lip. The angioma was located mainly on the right side of the upper lip, and involved the entire thickness. The lip was about twice its normal size. The angioma extended up to the nose, and showed some superficial enlarged vessels. The patient was from out of town, and it would have been rather difficult to have treatments repeated, so the case was treated by burying radium needles into the angioma. Under a light ether anesthesia, two platinum needles each containing 8.5 mg. of radium were buried in the angioma, and allowed to remain there for ten hours. This was followed by the usual reaction, swelling, induration and soreness, which promptly disappeared, and the tumor became gradually reduced in size until the lip was practically normal.

FIG. 3*b*. Result of one treatment with buried radium element in needles.

SUMMARY

The use of buried radium element in needles has been found practical in cavernous angiomas. No deleterious effects were noticed, although the reaction was fairly well marked. No bleeding was encountered. By using the buried radium needles, a greater effect of beta radiation was obtained. The time of treatment was shortened from a year to about one month. With proper technique, the results can be accomplished with one application only.

DISCUSSION OF PAPERS OF DRS. STRAUSS AND SCHMIDT

DR. HENRY K. PANCOAST, Philadelphia. The first case of Dr. Schmidt's I recognize as one of mine which I treated about 1920, by the external irradiation which Dr. Schmidt has described as having no effect, and I turned the case over to Dr. Clark for the purpose of having him try needle implantation. I am glad to see the result for I have not seen the patient since that time. Following Dr. Clark's work on

this case, I treated a patient myself, with the highest mortality I have ever had in any condition, 100 per cent. The patient died just one week later of pyemia. He was a physician who had a large angioma of the soft palate, and unfortunately he was also just developing a streptococcic infection in the throat at the time, but we did not know this. He became ill within twenty-four hours with fever and sore throat. His temperature fell again, but quickly rose. He rapidly developed multiple abscesses all over his body and in many organs besides. This procedure with angiomata is not without a very definite element of danger, which is not present in the treatment of tumor tissue by implantation. I do not know whether I will ever treat another case by this method or not, but I have hesitated to do so thus far.

Dr. William Neill, Jr., Baltimore, Md. It is gratifying that we have at our disposal such an agent as radium for the treatment of birthmarks in children and which can be employed with very little, if any, scarring. Our technique differs from that of the essayists in that we use considerably less dosage and treat entirely by gamma radiation. Before starting treatment it is well to caution the mother or parents as to patience, and co-operation, for improvement is not to be expected at once. It usually takes several months, a year or longer. We have never used the buried radium technique. It is of great advantage to have the mother massage the skin with a little cold cream every night after the treatment, as this helps to bring back the normal pigment. This is a minor point, but I think helpful.

Dr. Ira I. Kaplan, New York City. We have treated some hemangiomas in the roof of the mouth somewhat as Dr. Pancoast did, but we did not get a fatal result for we first attended to the mouth hygiene and then put in the needles. We did get a moderate amount of necrosis of the roof of the mouth. We have not used the severe dose Dr. Schmidt employed but small doses over a long period of time. We use a steel or platinum needle and find that we get better results than with unscreened radium. I think Dr. Schmidt's plan of inserting the needle through the normal skin is excellent. In one case we inserted the needles into the lesion and quite severe bleeding ensued. In one adult case, with quite large angiomas in the back, we implanted the needles, as we thought, in the proper manner by suturing to the outside, but one of the sutures broke and the needle went inside the hemangioma. The patient disappeared and we did not see him again for some time, but when he came back we were anxious to get the needle and took the risk of cutting into the hemangioma, and to our great surprise found it a mass of fibrous tissue. In the moderate sized hemangiomas of the tongue, radium is contrainindicated on account of the risk of tissue destruction. Endothermy is probably better in these cases and we have had excellent results from its use. In hemangiomas of the scalp we can avoid the bad result of loss of hair by implanting platinum needles. The epilation is much less than with the steel needles.

Dr. George E. Pfahler, Philadelphia. We cannot lay down a definite rule and treat all these cases as a class, but we must adapt our treatment to each individual case. Dr. Neill showed us a very nice result about the eyelids, obtained with filtered radiation and we could not ask for anything better. In that particular case I would treat with less filtration, for I cannot see that so much filtration is necessary in so small a lesion. Even if they extend deeply, I think that more than 1 mm. lead and 1 mm. brass is not needed. I think we will accomplish more by increasing the distance and get a better distribution of the radiation effects. In the type shown with the little growth on the cheek and another on the neck, we could destroy them with fulguration much more quickly and better, and with less scarring than was shown after the radium application. We must bear in mind that Dr. Schmidt has said that he is treating these cases that are covered with healthy skin, and that he goes through this skin in treating the tumor. That is very different from treating infected mucous membrane, and as we all know, it is very difficult to sterilize the mucous membrane of the mouth. I would be afraid to leave needles in place for twelve hours. It invites necrosis and may lead to abscess formation, and with a lesion on the face this might give a bad result.

Dr. T. D. Quigley, Omaha, Nebr. I remember being with Dr. Wickham of Paris in 1913 and seeing some beautiful pictures of the after-results of treatment of angiomas which he published later. The results they were getting before 1913 were fully equal to anything shown here today, and perhaps better. Those results were obtained by the use of the soft rays to a considerable extent. After going into the work myself in 1914 I tried out the gamma rays, compared with a beta mixture, and I have gone back entirely to the latter. We do not get satisfactory results when we confine ourselves entirely to gamma rays. Not all of these conditions are benign; some of them are malignant and some of them have a great possibility for recurrence if they are subjected to operation. About 1899 and 1900 I saw 3 cases of hemangioma in Dr. J. B. Murphy's clinic in Chicago, which recurred after opera-

tion and the patients eventually died. One was on the finger, another on the lip and the other near the eyelid. I think that with the radium treatment we can save these cases of malignant venous angioma that might otherwise result in death. In one of our cases of a woman, aged thirty-six, with a large angioma of the mouth which protruded between the lips, and the tongue also protruded, surface applications by needles reduced the growth within a very short time and this woman is still well. This case proves the fact that cavernous angiomas are amenable to radium in some instances. In another instance a little child was being taken through Omaha, and she had a mass on her eyelid so that she was mechanically blind when she sat up. The parents could remain only a few hours in Omaha and the child had only the one treatment, by a large dose of beta and gamma rays. Within three months we received a photograph of the patient showing an absolutely perfect result.

Dr. H. H. Bowing, Rochester, Minn. It is important to treat hemangiomas early. There is a prevailing impression that we should wait until the patient is ten or twelve years old, but this is a great mistake. In the treatment of large lesions in adults, for example, those involving the entire arm or the posterior or anterior walls of the chest, where they interfere with function and tend to bleed following slight trauma, surface radium packs have been employed. These hemangiomas may have destroyed important structures and as atrophic changes occur following the treatment, fixation may occur. However, the tendency to bleeding is markedly reduced. I seriously question whether or not these large hemangiomas in adults should be treated. I would be very reluctant to accept another case.

My second point is always to keep in mind the tendency to malignancy. I recall one patient with a huge hemangioma of the buttock, which could not be distinguished from the benign type, except that there was infiltration. Surface radium packs were applied. Reduction in the infiltration and in the tendency to bleed resulted. Later on, metastasis throughout the body caused the death of the patient. Personally I have always been inclined to apply surface irradiation as the treatment of choice but in a few cases I have buried the radium in the tumor, with good results. I agree with Dr. Pancoast, that there is a chance of infection, no matter how perfect the technique may be.

Dr. Truman Abbe, Washington, D. C. I should like to ask a question about an infant who in the first ten days of life developed a hemangioma on the abdomen, which grew pretty rapidly, from the size of a pinpoint on about the seventh day to the size of a dime in three months. During the second month a second nevus appeared on the back of the neck and assumed the same triangular shape as the spot on the abdomen. We then treated the spot on the abdomen with radium and it promptly stopped growing and disappeared. At the same time the spot on the neck though untreated also stopped enlarging. We raise the question, were these hemangiomas controlled by radium malignant, or were they benign?

Dr. C. J. Broeman, Cincinnati, O. The youngest patient I have ever treated for this condition was five days old. This infant had an enormous angioma, as big as an orange, on the neck, and was treated six years ago with surface applications. I saw the child a year ago (at the age of six) and the result was perfect. There was no sign of the original growth, only considerable loose skin was present where the growth had been, which will have to be removed surgically. The patient received only surface applications of radium at an inch distance, applying from 50 to 150 mg. in brass tubes and allowing it to remain from two to three hours at each application. This treatment was repeated every two weeks in the beginning for three months and then treatment was applied once a month.

Another case was that of a girl six years old with an angioma which extended from the hip down the entire leg, which was an inch larger in diameter than the other one. The pediatrician who referred her to me was afraid that she would develop a permanent elephantiasis. The patient was from Florida and came to Cincinnati every summer. She was treated with surface applications of radium at an inch distance over the entire leg. The treatments were repeated as soon as the patient recovered from radiation sickness which, as a rule, was from three to four weeks. We were able to reduce the leg to normal size and as far as I know, it has remained in this condition.

Dr. Oscar L. Norsworthy, Houston, Texas. No method of treatment has yet been proven best for all types of angioma. I presume that both essayists refer to the arterial type of growth, and not the venous. In our clinic, the venous type has been much less responsive to radium rays than the arterial. The small flat arterial type in young babies will disappear very quickly and without scarring, under desiccation. If larger than a copper cent piece, or if on an older child or adult, they are better treated with beta radiation. The varnish one-half strength plaque or a needle plaque applied close to the skin surface we have found most satisfactory. Thin rubber or alumi-

num should be used on a needle plaque on account of secondary rays.

The arterial type, most often elevated, is quite responsive to gamma rays of radium, and we believe this to be the treatment of choice. Well screened radium placed from 1 to 3 cm. distance for from one to four hours we find efficacious. The cavernous type with its elevated mass requires larger doses of radium at a greater distance, therefore, for longer periods. Treatments in all types should be about three months apart, and not so often if improvement is continuous.

Dr. Schmidt's results following embedded needles are remarkable. We have believed that 10 mg. needles embedded for twelve hours would produce necrosis which we do not want in angioma. Obliterating endarteritis is the desired effect. In adults where lymphangioma is to be considered, open surgery, I believe, should have preference over any type of treatment.

The type of mass that Dr. Bowing described in the fingers could have been a diffused venous plexus, and, as he said, radium is not the treatment. Extensive dissection of numerous veins is essential to best results.

Dr. R. P. Wadhams, New York City. I wish to discuss one point in regard to Dr. Strauss' paper on epulis. These growths are not so uncommon, they tend to recur locally and are usually seen in young adults. So far as I can remember, they are not usually seen in persons with bad mouth hygiene but in persons with well kept teeth. I think the surgeon has to extract the teeth, and do a fairly extensive, careful removal. I remember seeing one case that was treated by the implantation of two 7.5 mg. needles. The growth promptly disappeared and did not recur, at least for several years. I believe these epulis growths will disappear under radium and it seems to me it is of great benefit to the patient if they can be treated by radium rather than surgery.

Dr. Strauss (closing). I would not like to argue about what hemangiomas are, but I think they are true tumors. Their manner of growth and spread is still a matter of dispute among pathologists. I think the results we obtain show them to be true tumors. I would like to call attention to the article by Gunnar Andrén which appeared in the *Acta radiologica*, 1927, Vol. viii, p. 1, in which he goes over a great many cases of hemangiomata in great detail. It seems a difficult task to try to add anything to his article. His methods are well worth study.

Dr. Schmidt (closing). The cases I presented are ones in which the element of time was of most importance. It was simply a matter of getting rid of the angioma as quickly as possible and of avoiding the delay required by surface irradiation.

Infection is a real danger and must be borne in mind, but with due care, I think there is no reason why in these surface growths we should not be able to secure just as good asepsis as in any surgical condition. Under such circumstances, it is justifiable to use the embedded needles.

I agree that the treatment is more or less individual, and that we should study every case, and not try to formulate any set treatment. In the so-called strawberry marks, I never use anything but desiccation, as we can destroy them absolutely at one treatment. The rest is just a matter of healing, and the results are just as good and much quicker than with radium.

I have had perhaps half a dozen cases of epulis, all of which have occurred in early youth, except in one young woman who was twenty-three. I treated all these cases by desiccation, and have had no recurrences. They were all about the size of a pea, and in no case was it necessary to extract a tooth. One showed both behind and in front of the incisor tooth, and by using the desiccation slowly and carefully, I was able to destroy the growth with no injury to the teeth. Some of our cases had been operated upon before, with recurrence. The desiccation method is sure, and I think is worthy of a place in the treatment of these cases of epulis.

OSTEOCHONDRITIS DISSECANS*

BY G. E. RICHARDS, M.D.

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THROUGHOUT the history of medicine there have been numerous instances illustrating the narrowing influence which increasing knowledge exercises upon certain groups of diseases. In skin diseases the term "eczema" at one time included within its scope a great number of diseases which today are recognized as individual entities. As soon as their distinctive characteristics were recognized and described, a name was coined to give correct expression to this increase of knowledge and the group "eczema" was diminished by one more member. So it has been with cancer and numerous other disease groups.

And in a less degree this has been true of the foreign bodies, loose cartilaginous, or bony particles which occur within the knee-joint. There has been a tendency to group these all together simply as loose bodies and let it go at that. But in these days of routine examination of joints such a method is too loose and inaccurate, and it would seem well to direct attention to certain aspects of the subject which have not recently appeared in roentgen literature so far as I have been able to discover.

In 1887 König[1] described a type of loose body in the knee-joint which he declared to be entirely different in character and etiology from the ordinary loose cartilaginous body, or those arising from arthritic causes or detached fringes.

It was not until 1910, that a paper upon the subject appeared in English medical literature, this being a paper by Freiberg and Woolley.[2] Since that time numerous articles have appeared including an excellent one by Brackett and Hall,[3] Bernstein,[4] Balensweig,[5] and others.[6,7,8,9,10]

In most of the current books on roentgen-ray diagnosis and interpretation, this condition is not mentioned. In Holmes and Ruggles,[11] it is described briefly, and an excellent illustration of its occurrence in the knee-joint is given, but no description of its occurrence in any other joint.

Writing in the *Journal of Bone and Joint Surgery*, Freiberg[12] quotes König's original description of the condition as follows:

"Without any injury, there separate from the joint ends fragments of varying size, in consequence of a process as yet unexplained; their bony surface becomes covered with a dense connective tissue containing cartilage cells, here and there. In the same manner the defect in the bone becomes covered over. In some cases a smaller body composed entirely of bone and smooth with the appearance of necrotic bone, lay under a larger piece perhaps 2 cm. in diameter. These pieces often fitted almost exactly in the corresponding bone defect, seeming at times somewhat too large because the pits in the bone had become filled in. Aside from this, together with a fluid effusion and slight villous hypertrophy, these joints looked perfectly sound and they remained so after the removal of the loose bodies. (*Allgem. Chir.*, 1889, p. 751.)"

As Freiberg points out this is a remarkably accurate description considering that at that time the roentgen ray was not available, and the opening of the large joints was a very much more serious matter than at the present stage of joint surgery.

DESCRIPTION OF THE LESION

In the knee-joint the lesion is most clearly visualized in the anteroposterior roentgenogram. It may, however, also be visible in the lateral view and, if so, the additional information provided is of such importance as to make a study of the knee by stereos in both positions essential.

The defect is seen as a sharply defined shallow depression, irregularly circular in outline, and containing in its center a button of bone, the density of which may vary from that of a fully separated sequestrum to one differing so slightly from the normal bone about it as to entirely escape any but the most careful and painstaking

* Read at the Twenty-eighth Annual Meeting, American Roentgen Ray Society, Montreal, Canada, Sept. 20–23, 1927.

search. This defect is *invariably* found upon the outer side of the inner condyle of the femur immediately opposite the mesial tubercle of the tibial spine, and it is this unvarying position quite as much as certain other characteristics which is responsible for its recognition as a separate entity.

Various degrees of development may be observed from those cases in which the process is fully established to those which are examined during the early stage of the disease. Naturally the former are more characteristic and may therefore be taken as the standard of comparison. In such a case the button of bone has the density of a sequestrum lying in a sharply defined niche or recess just large enough to contain it. At this stage the loose body is frequently actually what it appears to be, namely, a completely separated sequestrum, requiring merely a slight force under proper conditions to dislodge it freely into the joint. It then becomes a "loose-body in the knee-joint," its origin frequently entirely overlooked.

In the earlier stages, the button of bone is still attached to the parent condyle, either by a broad base or by a pedicle and its density will be more or less determined by the degree of this attachment. If the degree of separation is slight, it may be that the variation in density between the button and the normal bone of the condyle is so slight as to be easily overlooked. In such a case the only indication of its presence may be an indistinct line of demarcation forming an irregularly circular outline upon the articular surface of the condyle in this particular location. But if this line can be established beyond question it may be considered of diagnostic importance. In one such case in our series this diagnosis had been made from the roentgenogram, but on opening the joint no loose body could be found. The line of demarcation, however, was located in the correct situation, and the surgeon was able to incise along this line and remove a characteristic button of bone lying in its niche fully separated except for its cartilaginous covering.

Freiberg also describes such a case so that the possibility must be considered as an occasional occurrence even though admittedly not common.

FIG. 1. Shows typical "button" on outer side of inner condyle.

FIG. 2. Very early case showing faint outline of "button" formation.

ETIOLOGY

Various theories have been advanced to account for this condition. König simply said they arise "in consequence of a process as yet unexplained."

The balance of evidence is in favor of a traumatic causation, and the structure of the joint appears to support this view. In the first place, the fact that the lesion occurs invariably in the same location on the inner condyle in itself suggests some specific cause; secondly, a study of roentgenograms of the knees in which it occurs shows an unusually long mesial tubercle of the tibial spine to be present in the vast majority of the cases. Under these circumstances it does not require much imagination to picture repeated slight traumatisms being delivered against the opposing condyle of the femur, especially in positions of extreme flexion.

Fig. 3. Small, well-marked defect in which the "button" has almost separated.

Fig. 4. Another variation, showing typical defect. Note long tibial spine.

In one of our cases the lesion was found in both knees of the same individual, and in both of these, the mesial tubercle of the tibial spine is elongated, thus suggesting a purely local process due to this peculiarity.

Some writers, particularly Ludloff (quoted by Freiberg) have attempted to explain the occurrence of the lesion by blocking of a small terminal vessel which has been demonstrated in this region of the knee, also by fat embolism occurring in the same or adjacent vessels.

These theories are undoubtedly interesting, and have been worked out with considerable care and skill. If the lesion were limited to the knee-joint the idea would probably demand a great deal of consideration, and, indeed, it may account for a number of the cases. The chief reason against its acceptance as the usual cause of the disease, however, would seem to lie in the fact that the disease is not limited to the knee-joint but occurs in several other joints in the body in which no such terminal vessels have as yet been demonstrated as existing. Until such a circumstance shall be shown to exist, the traumatic causation seems to be the only one which equally applies to all.

LOCATIONS OTHER THAN THE KNEE

(*a*) *The Elbow.* Freiberg describes a case as occurring in the elbow, the diagnosis being proved by operation. We have had one similar case in which operation was

refused, and the opinion therefore remains unverified.

In the elbow the lesion occurs upon the lower articular surface of the external condyle of the humerus where the excavation is clearly seen having sharply defined edges and no evidence of any inflammatory involvement of the bone surrounding it, or of the joint proper. The diagnosis of tuberculous disease is the most usual error though usually unjustifiable. There is no appearance of an inflammatory lesion or of any accompanying involvement of the joint proper. The picture is simply that of a sharply defined area of destruction with a sequestrum of dense bone contained within the cavity.

(*b*) *Hip-joint.* In addition to the foregoing we present here a case of osteochondritis occurring in the head of the right femur. The history insofar as we are interested in it is briefly as follows:

The patient was a young male, aged sixteen, at time of examination. At the age of fourteen, while driving a disc harrow his horses ran away. He was thrown off the seat and his foot caught in the brake. He was dragged some distance, suffering minor injuries and bruises. Afterwards it was found he had pain in the hip and was unable to walk. He was in bed one week, and after about one month was able to be about on crutches. At this time his hip was roentgen-rayed and pronounced normal. The injury was regarded as muscle strain only. No further treatment was given and since that time the patient has been able to get about with difficulty, and has been unable to work.

Physical Examination. Here the only finding of importance is slight abduction of the right leg and tenderness over the adductor muscles. Abduction is limited, with pain in the extreme position running down the inner side of thigh. There is no shortening.

Clinical diagnosis was slipped epiphysis.

Roentgen-ray Examination. Stereo roentgenograms of the pelvis show an area upon the superior articular surface of the right femur about $\frac{3}{4}'' \times \frac{1}{2}''$ in which a sharply outlined area of destruction is present, irregularly oval in shape, and in the center of this shallow depression a thin plate of bone or sequestrum is lying. There is no suggestion of general involvement of the joint cavity proper, or of any other portion of the articular surfaces except the localized patch described.

The superior rim of the acetabulum seems to project over this area of the head of the femur rather more than is usual, and the whole head of the femur is flattened, but there is no suggestion of the characteristic defect seen in slipped epiphysis. Accordingly a diagnosis was made from the films of osteochondritis dissecans and after some days an operation was performed for the removal of the sequestrum.

Operation. No difficulty was experienced in exposing the head of the femur, and here an area was found $\frac{1}{2}'' \times \frac{1}{2}''$ of which the edge was distinctly separated from the surrounding cartilage. A knife was inserted around this edge and a thin sequestrum lifted out. The

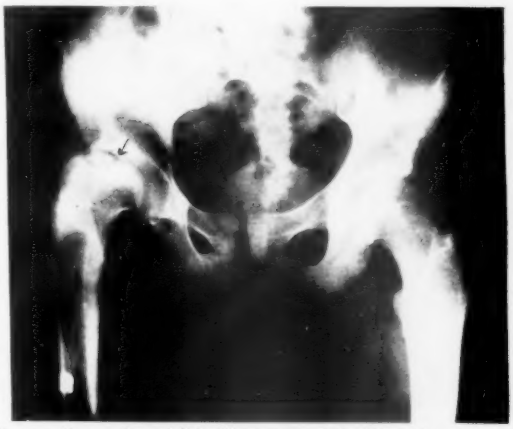

FIG. 5. Osteochondritis dissecans, right hip. The deformity in the head of this femur is not due to Perthes' disease.

crater was lined by hard bone, and there were no spicules or other loose fragments. Recovery was uneventful.

Pathological Report. The sequestrum was found to be dense fibrous tissue, and bone of the same type as that found in the typical lesion in the knee; and the pathological report was "osteochrondritis dissecans."

One of the most interesting points in connection with this case is the direct history of injury. Such direct histories have been rare or lacking in the knee cases, and this case would therefore lend support to the traumatic theory of the causation of these lesions.

(*c*) *Bones of the Foot.* Since this paper has been under preparation, a case has been studied in which it is believed the same lesion is present in the distal end of one of the metatarsal bones. Here, also, unfortunately for accuracy of diagnosis, no operation is likely to be permitted so that this opinion also remains unverified. The

lesion appears to conform in all respects to the fundamentals described above and found in those cases which have been verified, and we see no reason why the condition should not occur here as well as in other joints.

The common features include the following:

(1) A localized area of destruction within a joint, accompanied by the separation of a hard, fibrous sequestrum.

(2) In the knee-joint the location is always on the same site, viz; outer side of inner condyle opposite to the tibial tubercle.

(3) The mesial tubercle of the tibial spine in the majority of cases is unusually long.

(4) In other joints where the lesion has occurred it has been only in exposed positions and there has been a history of traumatism.

(5) The lesion is sharply defined, punched out, with very well-outlined borders, and there is complete absence of the roentgen signs of inflammatory or infective origin to account for this.

(6) The joint proper is not involved.

Finally it may be proper to add as an extra reason, if such be needed, for early and accurate recognition of the condition, that surgical removal almost invariably results in a radical cure of the disease.

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DISCUSSION

DR. PERCY BROWN, New York City. I think the general impression with regard to this lesion, in as small a classification as it would seem to be, is that it is of fairly recent discovery, but, as Dr. Richards said, it is seventeen years ago that Freiberg and Woolley presented the first English written communication on the subject. In that communication what appears to me to be the most interesting is the theory as to the causation of this lesion, particularly in the knee, based upon the element of internal traumatism. As Dr. Richards has said, it has been observed that the mesial promontory of the tibial spine has been found in many cases to be of extreme length, and we all know how often, as we cursorily examine the knee-joint, we see that one of the projections from the tibial spine is indeed much longer than the other. Freiberg's correlation between this appearance and between the direct causation of the condition is a very ingenious one and it is to be regarded with great seriousness because all of the statements of Albert Freiberg are dependable; he is a careful worker, a close observer. He said that where traumatism, as a causation, could be traced, it was usually sustained, with respect to the knee, in a position of extreme flexion and outward rotation. Then he and Woolley perhaps, or some other associate, went over a series of cadavers in an effort to produce a close physical relationship between a long internal spine or internal promontory of the tibial spine and what he said was a small artery known as the arteria genu media which was distributed over the partial crucial ligament. He also intimated that this pressure, sustained by this internal trauma, was such as to produce a distinct infarction in the mesial condyle similar to the infarctions seen in softer viscera, thereby producing infarcted anemia and the process of slowly developing bone degeneration. He then goes back to the point that there are in epiphyseal development many small terminal arterioles here which in the due course of events anastomose into a distinct collateral circulation, but for the time being in young individuals these blind arterioles give rise more easily to the production of an infarcted process.

On that basis, it seems to me that the most interesting phase to the roentgenologist in this condition, if we can only see it, is the observa-

tion of this local dystrophy in this condyle before separation takes place.

The great value of this present paper, is that Dr. Richards has made a distinct contribution to the literature on this subject in that he has presented a hip lesion, and the recorded hip cases are really very rare, as compared to the knee.

Dr. Merrill C. Sosman, Boston. If the hip case last shown is passed as a true osteochondritis dissecans, I should like to ask Dr. Richards how he explains the apparent thickening of the neck of the femur in that case? It struck me as being possible, or even probable, that this might be a case of so-called Calvé-Perthes' disease. We frequently get the fragmented appearance of the epiphysis in those cases and one of the important points in association with fragmentation is the thickening of the neck and the apparent deformity of the head, that was shown so well in the last slide of the hip.

Dr. Albertus Cotton, Baltimore, Md. I should like to call attention to the location of this shadow in osteochondritis dissecans. As Dr. Richards brought out, it has a definite location in the condyle. As roentgenologists, we are all familiar with the shadow of the sesamoid bone in the gastrocnemius. Some of the older members may know that in Williams' first book on roentgenology, this sesamoid bone is shown as a joint-mouse in one of the knee-joints.

Then the foreign bodies that we find in hip chondroarthritis of course are associated with the lipping of the femur.

In one particular case I had a man whose occupation was a brick-layer. He was accustomed to stooping a great deal, of course, and we could not place any definite trauma in various positions, but there was evidence of repeated minor injuries.

I had one case where the loose body was in the olecranon fossa. Whether that would be termed an osteochondritis dissecans or a joint-mouse, I would like to ask Dr. Richards. The loose body was removed with an anterior incision.

Dr. Henry K. Pancoast, Philadelphia. On several occasions I have found a small, round body, about the size of the end of a lead pencil, in the region between the tip of the acetabulum and the upper surface of the head of the femur. I don't know what this is. It may be something which is well known, with which I am not familiar. I wonder if Dr. Richards is familiar with this shadow and thinks it could possibly be one of these bodies, attached in the manner that he has suggested, and which has been there for some time.

I found the condition which I just mentioned on one occasion in a patient who had pain in the back. In another case it was found by accident. I have been unable to account for it, because there was no evidence that it had become detached in any particular place. This might also be evidence of a body that had formed in a similar manner.

Dr. A. Howard Pirie, Montreal. Like Dr. Pancoast, I expected Dr. Richards might mention that bone in the hip-joint. I have been very much interested in it myself. I have at least 8 cases of it now, and the professor of anatomy in Edinburgh has been hunting for the last two years in the Anatomy Department for this bone. Stereoscopically, it lies to the front of the joint. Sometimes it is in one side only but most frequently it is in both sides. At the present time we are calling it a sesamoid bone in the reflected head of the rectus femoris.

Dr. Richards (closing). I should like to thank Dr. Brown for his very illuminating addition to this discussion, and particularly his extensive quotation from Freiberg's original article, which is one of the most interesting and best articles in the literature on this subject.

Dr. Sosman asked regarding my idea about the thickening of the head of the femur and how we would differentiate this from Perthes' disease. I presented the case of a young boy fourteen years of age, who was injured, and it was followed immediately by this disability. It involved not only the head of the bone but the cavity of the acetabulum as well, and they are both molded in unison.

In my own observation, I have never seen in Perthes' disease such a complete separation of the sequestrum.

The fact that carried more weight with us than anything else was the known fact that Perthes' disease is a progressive metabolic disturbance and that this case was specifically due to an injury.

I would not want it thought that we were including the sesamoid bone, in these films, as a loose body.

As to the speaker who referred to a case in the elbow, in which he saw the same type of sequestrum in the coronoid process, I have no particular opinion on that. It would seem to be the same type of sequestrum which we see elsewhere, and I think it is easily possible that that might also be a case of osteochondritis dissecans.

Dr. Pancoast referred to these small, round bodies which occur between the tip of the acetabulum and the upper surface of the head of the femur. We have observed them reasonably often; so much so that I was able to present a series of more than a dozen within a

period of six months, in which either there was a well-developed unilateral or a bilateral lesion, and we felt that they were merely an anatomical variation and that they probably were sesamoid bones, as Dr. Pirie pointed out. Not one, so far as I know, has dissected one of those out, to see what it is.

Dr. Hickey, in conversation, has said that they have been described in the German literature as the sesamoid bone and that they are not pathological.

I am not sure that I fully understood the location of the lesion in the spine, to which Dr. Pancoast referred. If I am speaking wrongly, he will correct me. We have observed those densities in the intervertebral disc. We believe that they are a process of ossification of the cartilage. They usually begin pretty well at the center of the cartilage. I do not know of any one who has studied one in autopsy.

The chief object I had in presenting this paper was that I felt the general impression had been that this was a recent discovery. It is one of those cases in which we may profit by having attention drawn to it and thereby add to the accuracy of specific details in our reports.

In one of the cases, as I pointed out, if an x-ray had not been taken, the surgeon would have closed the incision without finding any loose body at all.

FINDING TUBERCULOSIS FOR THE GOOD OF THE PUBLIC HEALTH*

BY EUGENE L. OPIE, M.D.

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THE first step towards the control of tuberculosis is the discovery of those who have the disease. The search for patients who have advanced tuberculosis and are a danger to others because they scatter tubercle bacilli is a pressing problem of public health. Recognition of the disease in its earliest stages concerns the welfare of the patient primarily, it is true, but, promptly followed by appropriate measures, it is also effective in diminishing the number of persons who spread the contagion. Educational propaganda, reporting of tuberculosis and the establishment of tuberculosis clinics are the means by which the finding of cases is promoted. The results hitherto have been disappointing. An effective search for tuberculosis is as yet something "good, won by merely wishing we could."

The usual methods of physical examination in most instances establish the presence of pulmonary tuberculosis only after impairment of health has begun. Loss of weight and elevation of temperature are symptoms of advanced tuberculosis and physical signs of pulmonary disease are usually associated with them. On the other hand, it is well known that serious tuberculous infection may be unaccompanied by any recognizable evidence of constitutional disturbance. Animals inoculated with tuberculosis increase in weight and show no evidence of illness until the disease is far advanced.

The importance of identifying tuberculous patients in whose sputum tubercle bacilli are demonstrable by the ordinary methods of examination will scarcely be denied by any one familiar with the disease, but the value of this commonplace procedure as a means of discovering those disseminating the disease and those exposed to infection is not fully understood. At all events, sputum examination is not widely used as a guide to prophylactic control. Lack of the meager laboratory facilities required to make numerous sputum examinations is sometimes responsible for this neglect.

The families of patients under the care of dispensaries for tuberculosis should be classified, (*a*) exposed, now or formerly, to tuberculosis with sputum containing tuber-

* Published at the request of the National Tuberculosis Association as a part of the Early Diagnosis Campaign.

cle bacilli and (*b*) exposed to tuberculosis with no tubercle bacilli in the sputum. Examinations should be repeated with sufficient frequency to establish the accuracy of the classification.

Experience at the Henry Phipps Institute during the last few years has shown:

(*a*) In families of which some member suffers or has suffered with tuberculosis with sputum containing tubercle bacilli, children and adults are usually infected with tuberculosis and the infections are often severe.

(*b*) In families of which a member has tuberculosis with sputum negative for tubercle bacilli, tuberculous infections are far less frequent and severe. In most of these families the tuberculous patient has scattered no tubercle bacilli, although there may have been temporary elimination of tubercle bacilli before the period of observation. However, the patient with tuberculosis and sputum negative for tubercle bacilli is a potential source of danger and must have repeated examinations to determine whether tubercle bacilli have appeared.

(*c*) In families of which some member is suspected of having tuberculosis, infection of children has not been more frequent than in families having no contact with manifest disease.

By sputum examination the clinic established to combat tuberculosis can identify those who disseminate contagion and can discover a large part of those who are exposed to the danger of grave infection.

For the diagnosis of tuberculosis before there are significant symptoms or physical signs two methods are available, namely, the tuberculin test and roentgenological examination.

The difficulties of early diagnosis of pulmonary tuberculosis in young children are well known and unless the tuberculin test is used it is rarely possible to make the diagnosis until general health has been undermined. Significance of the reaction (best performed by intradermic injection of measured quantities of tuberculin) varies with different ages and is greatest in early childhood.

A child under one year with positive tuberculin reaction should be the object of special care, for it suffers with infection that will probably prove fatal. Recovery of some infected children, whose number increases from the sixth to the twelfth month of age, modifies prognosis but does not impair the diagnostic significance of the reaction.

A positive tuberculin reaction in several members of a family, especially in those below the age of ten years, indicates that they have been exposed to open tuberculosis in the household, and, on the contrary, negative reactions in all children of a family show that there has been no exposure.

When in the absence of physical signs and significant symptoms, grave tuberculous lesions are recognized by roentgenological examination their significance increases with the intensity of the tuberculin reaction. When lesions recognized by roentgenological examination alone are accompanied by negative tuberculin reactions they are probably healed.

The prevalence of the reaction in adults restricts its value but should not be cited as an argument against its use. The same statement may be made about occasional instances of far advanced tuberculosis in which the reaction has disappeared.

Diagnosis of tuberculosis as of other diseases depends upon the accumulation of all available information, but without roentgenological examination recognition of the grave tuberculosis that has not yet affected general health is usually not possible either in children or in adults.

In apparently healthy persons the tuberculin reaction shows the presence of tuberculous infection, but roentgenological examination is necessary to determine the position and extent of tuberculous lesions unaccompanied by physical signs. Furthermore, the discovery of abnormal density in some part of the lung field may suggest the site of physical signs that might otherwise be overlooked. The physician must qualify himself to take part in the interpretation of plates.

Advanced tuberculosis of the tracheobronchial lymph nodes may be recognized in children with no physical signs of the disease, and in some of these instances latent disease ultimately becomes manifest.

Spots of abnormal density in the lungs of children are often, but by no means always, caused by tuberculous infiltration. Recognition of the disease is aided by discovery of associated tuberculous tracheobronchial lymph nodes and by the tuberculin reaction.

It is often possible to recognize apical tuberculosis of adults unaccompanied by physical signs. Approximately one-half of the husbands or wives of those who suffer with open tuberculosis have recognizable apical tuberculosis. A considerable part of the adolescent children exposed to open tuberculosis acquire apical lesions, and after lapse of years symptoms and physical signs may make their appearance.

Members of households who have been exposed to open tuberculosis should receive repeated roentgenological examination to determine the presence and severity of tuberculous infection.

CONCLUSIONS

Discovery of tuberculosis before it has impaired general health and at a time when it can be arrested with considerable certainty is an important function of municipal dispensaries established to combat the disease.

By the routine use of the tuberculin test many errors in the diagnosis of tuberculosis in children may be avoided.

In dispensaries not equipped to give adequate roentgenological examinations recognition of the earlier stages of the disease in children and adults is not possible. The expense involved is doubtless considerable but is essential to effective "case finding."

Dispensaries so unfortunately situated that they have no access to an adequate roentgenological laboratory should give special attention to the examination of the sputum for tubercle bacilli, and should classify families under their care in accordance with its results, for in the households of patients with open tuberculosis will be found a large part of those who will ultimately develop the disease.

THE EARLY DIAGNOSIS OF TUBERCULOSIS*

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IN the short space at my disposal I must limit myself to a few remarks on the recognition by the general practitioner of early cases of pulmonary tuberculosis. If the doctor is to get the brilliant results which early recognition and intelligent handling permit, he must, when patients consult him, be keenly on the lookout for those early symptoms which should always suggest to him the possibility of tuberculosis and yet which are so often overlooked or mistaken. Tuberculosis is so common a disease that every doctor must have its possibility in his mind.

The diagnosis begins with the realization by the doctor of the possible meaning of the patient's complaints. These should at once arouse his suspicion, yet too often he obstinately refuses to consider their significance.

His suspicions being aroused by the patient's report, a carefully taken history with tuberculosis in mind will make half of the diagnosis in incipient cases. The early case is apt to give either an asthenic or a catarrhal history, though some very early cases begin with a small hemorrhage.

The asthenic case has usually been tired and run down and below par for some time, off in appetite, weight and color or with dyspeptic symptoms. There is some cough but not as marked as in the catarrhal type, and the sputum at first is scanty or absent, but every effort must be made to collect and examine it carefully. The fever at first is apt to be moderate, in the 99's, or may be absent, but if studied every two hours will generally be found, at least after exercise. While many of these symptoms are common to various diseases, pulmonary tuberculosis is so common that they should at once excite our suspicion. This insidious onset, marked especially by tiredness, is the most common form and is often mistaken for neurasthenia, dyspepsia or anemia, with disastrous results.

The catarrhal case comes complaining of an irritating cough of some duration, with a moderate amount of sputum. It has been mistaken for influenza or bronchitis until its duration alarmed the patient. As the temperature comes on there is evening tiredness and here the microscope and the thermometer will not fail to put the careful doctor on the right track. Hoarseness is common and loss of weight usual.

A small hemorrhage initiates the hemorrhagic type, and the physician who would belittle a hemorrhage, however small, and fail to recognize its significance is playing with life and is unworthy of a diploma. Yet too often the cough is explained as due to smoking, the tiredness to overwork and the blood to a "broken blood vessel" in the throat, and many cases give histories of several hemorrhages each mistaken by the doctor while the disease had time to progress.

Some cases begin as a pleurisy and the profession cannot be too careful to warn every case of pleurisy that it is usually only another term for early tuberculosis.

The patient's symptoms having suggested tuberculosis, a careful and searching written history must follow. Investigation of all those in the family or in the patient's environment will often reveal hitherto unsuspected cases of chronic cough or of "nervous breakdowns" in the family or those with whom they have been associated. The hygiene of the home must be gone into carefully, the childhood history may show frequent colds or coughs, enlarged cervical glands, malnutrition, anemia, pleurisy or pneumonia. The past life from puberty to the present sickness will often reveal forgotten and suggestive sicknesses, winter colds, pleurisies, etc., while a study of the exact conditions of life, hours and places of work and nature of amusements give us many valuable hints. The present complaint has been already found out but can now be further detailed and is, of course, the crux of the history.

I have found it useful to ask the patient "When were you last perfectly well?" for

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they are prone to date the sickness back only a short time to some striking symptom and to overlook important long precedent symptoms. Not rarely the sickness can thus be traced back for months or years. The physical examination while it need not be as minute as that of the specialist must be accurately and systematically carried out and recorded on a proper chart both for future comparison and to make sure that a proper routine is followed.

The room must be about 70° and the light must fall vertically on the chest to allow of accurate inspection. I hope it is no longer needful to note that the patient's chest must be entirely exposed. Inspection well done is almost as valuable as auscultation in early cases and must never be neglected. Very early in the development of tubercle in an apex or upper lobe the surface of the suprascapular fossa flattens and later hollows, the shoulder outline from neck to acromion, which is normally slightly convex, flattens and becomes a straight line, while the clavicle becomes more prominent. Later the shoulder on the affected side droops and in deep breathing lags or is retarded. To see these at first very slight changes demands care, time and proper lighting, and at times retardation will be better shown by palpation. Mensuration gives us two very useful facts. Measuring the hemi circumference R and L from the 8th spine to the center of the sternum at the 4th rib at inspiration and at expiration will very early reveal shrinkage of the affected side and limitation of motion, unless an old healed lesion exists in the good side. Marking the location of the base of the lungs in front and behind at rest and after deep inspiration will reveal limitation of motion on the affected side very early and is an invaluable procedure.

Percussion unfortunately calls for especial skill if it is to be valuable and not misleading, and is often so badly done as to be valueless.

The blow must be light, save on the muscles of the back, the rebound quick and elastic, the motion confined to the wrist or metacarpo-phalangeal joint. The ear must be trained to recognize length, pitch and quality and these changes can more easily be heard by percussing from resonant and less resonant areas.

Good percussion will reveal quite early shortening and impairment of the note over the apex in front and behind, but real dullness is not an early sign. The careful mapping out of the outer and inner borders of the area of apical resonance above the clavicle (Kroenig) is very valuable in revealing early shrinkage of the apex, which begins very soon after development of tubercles in the upper lobe, but it demands a thorough command of percussion.

Auscultation is our most accurate means of diagnosis despite those who would place the roentgen ray first, but the doctor must be able to interpret its findings in terms of pathology correctly, not always an easy task. Auscultation must be comparative from side to side and vertical from bottom to top. Attention must be paid to the pitch, quality and duration of the breath sounds and to the nature, quality and time of râles. Any breath changes or râles to be significant must be limited in area and persistent, or must return later if cough removes them, hence in doubtful cases our examination should be repeated at different times, especially on waking.

The diagnostic value of breath sounds in very early cases I would state as (1) granular, (2) feeble, (3) harsh and prolonged, (4) cogwheel, (5) vesiculo-bronchial, (6) broncho-vesicular, though this is scarcely an early change. What I have called granular breathing, called by some rough, is the "respiration rude" of the French, or the "rauhes athmen" of the Germans and was especially stressed by Grancher. The breath sound, instead of being continuous and smooth as in normal breathing or interrupted as in cogwheel, shows rises and falls of intensity and sounds almost as though it were about to break into moist râles. A patch of this breathing limited to a small area and persistent is a very valuable early diagnostic sign and before long râles will appear in this area if the case progresses. Feeble breathing is suggestive but not so diagnostic, while prolonged harsh expiration is strongly suggestive. As the case becomes less incipient, vesiculo-bronchial

breathing, evolving soon into distinct broncho-vesicular, which is not an early sign, appears. Cogwheel breathing comes with an inflamed pleural surface rather than with parenchymal changes.

The typical râle of early tuberculous infiltration is the fine dry crackle of Walshe. Distinctly dry, sharp, few in number, heard at the end of cough following expiration and limited to a small area and persistent, they are our most diagnostic sign, but a diagnosis must often be made from the inspection and breath sounds before râles appear. When they develop into larger dry crackles and then into fine or medium moist râles (unfortunately called subcrepitant) they give us invaluable information of the pathology and development of the process, but are not extremely early. Still a crop of fine or medium moist râles is an ominous and an invaluable sign of the fire that is destroying the lung.

In early cases râles will be heard only after cough following expiration, or at least deep breath; when heard on quiet breathing the disease is well advanced.

In the space at my disposal I cannot treat of the roentgen ray as a diagnostic measure, and the majority of doctors will not command the skilled procedure and interpretation which make it invaluable. The physician should be able to diagnose most cases without its priceless aid though no man who specializes in tuberculosis could dispense with it, but it must be taken by an expert and interpreted by him, and to rely on it alone for diagnosis is an unpardonable error. If we must dispense with the regular steps or the roentgen ray let it be the latter, but it gives the expert a breadth of information that is wonderful and invaluable.

When the examination is finished all the data must be gone over carefully, the positive facts assembled, the patient considered as an individual and not just as a case, and then a conclusion drawn; but an early case may have to be watched and studied for some time before we can give an opinion.

A two hourly temperature and pulse record, first at rest, then after exercise, must be taken and we must never fail to seek for and examine the sputum carefully and repeatedly. I have found it a good thing to underscore in red in the history and the examination chart each positive finding. Such an examination need not be too time-consuming but in any case where a human life is involved we cannot afford to slight anything. Such a procedure followed by the general practitioner will reveal many cases while still curable, which now, too often from carelessness, go unrecognized till the opportunity for cure is gone.

AN UNUSUAL ROENTGENOGRAPHIC FINDING IN THE HIP

BY PHILIP LEWIN, M.D.

Associate Professor o Orthopaedic Surgery, Northwestern University Medical School

CHICAGO, ILLINOIS

THE accompanying illustration (Fig. 1) reveals an unusual roentgenographic finding, viz., coxa vara, with a shadow

FIG. 1. Roentgenogram of hip regions presenting the appearance of adventitious bones of semilunar shape, with epiphyseal coxa vara or "slipped epiphysis."

at the lower margin of the capital epiphysis presenting the appearance of an adventi-

FIG. 2. Facial expression of cretinism or infantile myxedema.

tious bone of semilunar outline. This has been variously interpreted as the lesser trochanter, a split off portion of the capital epiphysis and a separate ossification center.

The patient is a white girl referred by

FIG. 3. Limitation of abduction due to epiphyseal coxa vara.

Dr. I. A. Abt. She is nine years old but wears the clothes of a child of six. She was examined because of a limp due to dipping on the left side. This had been present for several months and no cause could be ascribed.

There was no other complaint whatever. Examination revealed an undersized child 47 inches in height and 58 pounds in weight. Her facial expression was that of cretinism or infantile myxedema (Fig. 2). Her gait was suspicious of a mild dislocation of the left hip, but both femoral heads could be palpated in the acetabular fossae. Abduction was limited as shown in Figure 3.

A diagnosis of a glandular disturbance was made and the following prescribed:

Thyroid extract, grains ½ t.i.d. Whole pituitary gland, grains 5 t.i.d. She was also started on medical gymnastics, especially forcible abduction of the legs. After one month, definite increase in abduction with marked improvement in gait was noted.

FOREIGN BODY IN THE RECTUM

BY CHARLES D. CLEGHORN, M.D.

Consulting Radiologist, James M. Jackson Memorial Hospital

MIAMI, FLORIDA

FOREIGN bodies in the rectum are quite common, being either ingested with food, swallowed by mistake, inserted through trauma, or introduced voluntarily. The following case is interesting from various standpoints: the size of the foreign body, the length of time it was *in situ* before a physician was consulted, the method of removal, and the resulting injury and death.

FIG. 1. Foreign body in the rectum; anteroposterior view.

FIG. 2. Foreign body in the rectum; lateral view.

CASE REPORT

W. W., white male, aged forty-nine. Admitted to the surgical service of Dr. C. F. Sayles on December 12, 1927. The patient stated that an ice pick had been inserted in the rectum for sexual gratification on December 2, that it had slipped from his grasp, and that efforts at recovery of the instrument had been futile. He complained of some abdominal pain. The bowel movements had been free and liquid in character, with some bloody mucus.

The physical examination showed a well-nourished man; head and chest negative. The abdomen was somewhat distended, free from rigidity. It was tender on deep palpation just above the symphysis pubis. A small mass was palpable just to the left of the median line above the umbilicus. No foreign body was palpable in the rectum.

Roentgen-ray Report. There is a metal foreign body, like an ice pick with a wooden handle, seen with the point directed downward opposite the last sacral joint. The handle is directed upward and to the right, lying opposite

the transverse processes of the 3rd and 4th lumbar vertebrae. On the lateral view, the point is seen in contact with the sacrum, the handle lying just in front of the 4th lumbar vertebra. The ice pick lies, therefore, in the sigmoid.

The temperature was normal. The urine showed a trace of albumin and some pus cells. Proctoscopic examination failed to reveal any foreign body but it was accompanied with a great deal of pain.

Operation, December 15. A left rectus incision was made and the ice pick was found to lie in the sigmoid with the point through the intestine and the parietal peritoneum about 1 inch above the pelvic brim near the ischium. The punctures were well agglutinated and no peritonitis was observed. The bladder was dilated and on catheterization 1½ quarts of urine was withdrawn. A rectal tube was inserted in the rectum and was passed up to the point of the ice pick. By manipulation the point of the pick was thrust into the open end of the rectal tube, and the pick was then shoved down by pressure over its handle until an assistant with the gloved hand in the rectum was able to remove the tube and ice pick.

The latter measured 10 inches in length. The opening in the sigmoid was gangrenous, about 1 cm. in diameter. The opening in the parietal peritoneum and posterior abdominal wall was about the same size. A silk purse string suture was used to close the sigmoidal wound followed by intestinal sutures to reinforce. The peritoneal wound was stitched with two interrupted intestinal sutures very loosely. No drainage was used. The skin was closed in the usual manner.

In two days abdominal pain became very severe. Temperature rose to 102° F. Bowel action was good. There was no rigidity or distention. Some cutaneous crepitus became noticeable on the ninth day. The pain increased and the patient died on the tenth day from infection of the punctured wound, probably with the gas bacillus.

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Information of interest to all readers will be found on page ii.

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EDITORIAL

THE EARLY DEVELOPMENT OF ROENTGENOLOGY *

AMERICA takes great credit for the early use of the roentgen ray in the examination of the chest and the gastrointestinal tract, and that it is able to do so is dependent upon the work of Francis H. Williams and Walter B. Cannon of Boston. The vision of Williams in grasping the possibilities of the roentgen ray in the diagnosis of diseases of the chest is nothing less than astonishing. The roentgen ray was announced to the world on December 21, 1895, and in the April, 1896, number of the *Boston Medical and Surgical Journal* Williams published a paper setting forth his observations on the study of intrathoracic conditions by means of the roentgen ray. His papers published in 1896 and during the succeeding five years and his book published in 1901 and 1903 exerted a great influence in establishing the value of the roentgen ray in the diagnosis of pulmonary tuberculosis, thoracic aneurysm, pleural effusions and other intrathoracic diseases. One has only to read his works in the light of our knowledge today to recognize his unusual vision and the sane balance that he at all times maintained.

Williams was greatly assisted in his work and, in fact, much of it was made possible by the scientific ability and the mechanical genius of William H. Rollins, his fellow townsman. Rollins developed all sorts of roentgen-ray apparatus and accessories, made improvements in roentgen-ray tubes and wrote numerous articles for the medical periodicals of the time on the problems of the physics of the roentgen ray and the technique of roentgenology.

But valuable as Williams' work was in establishing and popularizing the roentgen method of examination of the heart and lungs, there is another field in which he was a real pioneer and for which he has received scant recognition. A. W. Crane has called attention to the fact that Williams was the first to use a bismuth salt in human beings for investigation of the gastrointestinal tract. Walter B. Cannon's classical studies of the gastrointestinal tract in animals after ingestion of bismuth subnitrate were published in the *American Journal of Physiology* in 1898, and Williams in his textbook published in 1901 reports two cases of children whom he examined in 1899. In a paper read before the American Medical Association June 6–9, 1899, Williams makes the following statement: "By giving subnitrate of bismuth, which is opaque to the rays with a meal, the outline, position and size of the stomach may be seen and its diminution in size during the process of digestion and the changes in outline during its peristaltic movements may be followed." In 1897 Theodore Rumpel had reported in the *München. med. Wochenschrift* on the diagnosis of dilatation of the esophagus first by means of a tube filled with shot and later by means of bismuth subnitrate suspensions. In 1898 Boas and Levy-Dorn in a paper published in the *Deutsche med. Wchnschr.* described the employment of celluloid capsules containing a bismuth salt for examination of the gastrointestinal tract. The authors stated that the capsules could be watched on the screen. They were enabled to diagnose pyloric obstruction. As is well known, the bismuth meal came into general use when Rieder published his work in the *München. med. Wchnschr.* in 1904.

The therapeutic use of the roentgen-ray began with the report of Freund in the *Wien. med. Wchnschr.* of March 6, 1897, of the removal of hair from a large hairy nevus, although Despeignes had reported in *La Semaine Médicale* for July 29, 1896, that he had exposed the abdomen of a patient who was suffering from cancer of the stomach, to roentgen rays. Schiff and Freund also reported in 1897 on the roentgen treatment of tinea tonsurans,

* Continued from the February issue of the Journal.

sycosis and favus. Eczema was apparently treated first by Hahn who reported two cases cured by roentgen treatment in Volume II of the *Fortschr. a. d. Gebiete der Röntgenstrahlen*. Jutassy reported the cure of acne vulgaris in 1900.

The first treatment of cutaneous disease by the roentgen ray was the work of Kümmell and his associate Hermann Gocht who reported on the treatment of several cases of lupus vulgaris. In September, 1897, in the *Fortschr. a. d. Gebiete der Röntgenstrahlen*, Gocht reported on the treatment of six cases of lupus vulgaris, two cases of mammary cancer, one case of nevus pilosus, one case of trigeminal neuralgia and one case of removal of hair from a wound. There were numerous cases of lupus vulgaris reported both in Europe and America before 1900.

The first cases of malignant disease effectively treated by the roentgen ray were cases of cutaneous carcinoma. Stenbeck of Stockholm, and Johnson and Merrill of Washington, D. C., reported cured cases of epithelioma in the year 1900. Stenbeck had demonstrated his case at a meeting of the Swedish Medical Society on December 19, 1899, so that priority lies with him. Johnson and Merrill's cases were the first reported in the United States.

Gocht, in 1898, was the first to report roentgen-ray treatment of two inoperable breast carcinomas. Relief of pain was noted in the first case; the second died soon after the beginning of treatment. Up to 1902 a number of writers in the United States had reported treatment of breast carcinoma, among them Johnson and Merrill, Soiland, and Pusey and Williams. Some of the cases were primary and some recurrent after operation. A considerable number of cases showed disappearance of clinical evidence of disease. Wm. Allen Pusey states in his book written in conjunction with Caldwell and published in 1903, that he began postoperative prophylactic roentgen-ray treatment of malignant disease in 1901, and in 1903 he gives the results in twenty-one cases. Pusey also recommended the pre-operative use of x-rays in certain cases of malignant disease.

Within the first year after the discovery of the roentgen ray there began to be reports of injurious effects due to exposure to the roentgen ray. In the *British Medical Journal* for 1896 Sidney Rowland described the trophic effects on the skin. In the *Canadian Practitioner* for 1896 Edmund King reported the case of a man who gave public exhibitions with the roentgen ray. He suffered from exfoliation of the nails, atrophy of the skin, ulcerations on the face and hand and loss of hair. During the first two or three years there was much argument, some of it acrimonious, as to the cause of the injuries. The state of opinion at the end of 1897 was well summarized in the presidential address of Sylvanus P. Thompson before the British Röntgen Society on November 5, 1897, as follows:

"But if the Roentgen ray has brought to the medical practitioner such a powerful aid, it has also brought new and bewildering problems. Soon after the invention of the focus tubes had furnished powerful sources of Roentgen rays, it was noticed that exposure to them frequently resulted in severe local inflammation of the skin, accompanied in some cases with destruction—at least temporary—of the hair, which fell out, leaving bald patches. One of my own assistants suffered for some six weeks from a bald patch above the ear, as the result of an attempt to skiagraph his skull. Many have lost the small hairs from their hands. One instance is reported of a baldness which threatens to be permanent. It is disputed whether this effect is a direct effect like sunburn, whether it is indirect and due to the chemical action of ozone generated by the ionizing of the oxygen of the air, or whether, finally, it is an electrical effect. Our hon. secretary, Dr. Walsh, has found that it may occur even deep-seated within the tissues. Some assert that this curious dermatitis is prevented by interposing a sheet of aluminum. If this is true it would seem that the effect is electric in its origin. On the other hand, cases are known in which the inflammatory symptoms have occurred on the side of the body furthest from the Crookes's tube. Some persons are much more sensitive to this effect than others: some apparently wholly insensitive. The existence of this singular affection has given rise to the suggestion that the Roentgen rays may possibly be found to have some useful pathological application for the treatment of such diseases as leprosy—possibly even for tuberculosis. The suggestion that they might be useful as a destructive agent to kill bacteria, has led to various researches, but so far with an entirely uncertain result."

Writing in the *American X-ray Journal* in 1898, Charles Lester Leonard stated his opinion that the injurious effects upon the skin are due to the static electric field and not to the roentgen rays. He offered as proof of this experiments in which a sheet of aluminum well grounded had been placed in the path of the rays and had given protection. He says: "It is therefore reasonable to conclude that the devitalizing action attributed to the Roentgen ray is due to long continued or intense static charges, while the therapeutic action is the stimulating effect of a mild and judiciously employed amount of the static charge."

Prof. Elihu Thomson had performed an experiment and published his conclusions on this matter in the *Boston Medical and Surgical Journal* in 1896 that should have set it entirely at rest. He used a blue glass tube with a window of clear German glass. He exposed his own finger and produced a burn only on the part opposite the clear glass through which the roentgen rays could pass. He published additional experiments in the *American X-ray Journal* in 1898, but even as late as 1903 there were still writers who contended that the injurious effects were due to ozone, chemical effects or to electro-static discharges.

In 1897 N. Stone Scott collected sixty-nine cases of roentgen-ray injury. He concluded that injury was very rare when proper precautions were taken. A careful study was made of all the recorded cases by E. A. Codman in 1902 and his results published in a paper in the *Philadelphia Medical Journal* of that year. The following quotation from that article states what was the commonly held opinion at that time with regard to the cause of the injuries: "Most writers agree that the active cause is not heat nor the brush discharge, nor the photographically active x-ray itself, but some form of energy radiating from the platinum terminal together with the x-ray, and probably closely related to it on the one hand and to ultraviolet light on the other." Codman's conclusions were that injury was very rare when compared with the enormous number of roentgen-ray exposures that were being made. He had been able to collect less than 200 cases from the entire world, less than half of which were serious and about one-third of which had occurred in roentgen-ray workers.

It must seem astonishing to us today not that injuries occurred in those early days, but that they were not exceedingly common. It seems probable that very frequent injury was prevented only by the limited output of the coils and static machines, and especially by the fact that tubes could be operated continuously for only comparatively short periods. It must be considered a very fortunate circumstance that there were no hot cathode tubes in the days before methods were devised to measure dosage. With regard to the latter point, the following was Kienböck's method of regulating his dose in treatment cases. He used a medium soft tube which he placed at a distance of 15 to 20 centimeters from the surface to be treated. He protected the surrounding skin with sheet lead. The tube was one capable of producing a good image of the chest of a medium-sized man when viewed through a roentgenoscope at a distance of 60 cm. With this tube he gave what he called an average exposure of twenty minutes which after fourteen days caused the hair to fall out and produced an erythema. He also described methods of fractional dosage.

The principal reason that injuries were not common in treatment work was that most of the workers early learned the danger and gave very small fractional doses and watched the skin carefully for evidence of reaction. Williams seems to have been the first to enclose the tube in a box painted on the inside with lead paint. Of course the greatest difficulty faced by the early workers was the instability of the vacuum in the roentgen-ray tubes; most of the other factors could be somewhat standardized.

The common practice of using the hand behind a roentgenoscope to estimate the quality of the ray was the cause of many of the injuries to roentgen workers.

Elihu Thomson had suggested in 1896 that an aluminum screen be placed in the path of the rays and when this became generally used it of course resulted in decreasing the danger of exposure.

Codman in the article in the *Philadelphia Medical Journal* previously referred to

gave a very accurate description of the chronic dermatitis in roentgen-ray workers. Johnston in the same volume of the *Philadelphia Medical Journal* was the first to call attention to the danger of epitheliomatous changes in the keratoses of chronic roentgen-ray dermatitis. He called these lesions precancerous keratoses.

Space precludes continuation of the story through the succeeding years. In closing, mention should be made of a few of the early contributions of men of our own country to the science and art of roentgenology. The invaluable work of three men of Boston—Francis Williams, William Rollins and Walter B. Cannon—has been mentioned all too briefly. Gratitude to a martyr as well as recognition of his pioneer work would not permit the omission of the name of Walter Dodd who began his work in the Massachusetts General Hospital in 1896, and in that same year suffered injuries from which he never fully recovered. I have also mentioned the work of Elihu Thomson, Michael Pupin and Thomas Edison. Then there were Caldwell of New York and Kassabian and Leonard of Philadelphia, all of them martyrs to the unknown ray. The recent passing of William Sweet has recalled his work on the localization of foreign bodies in the eye begun in 1898 and culminating in his improved apparatus which was described in 1909. We would like to say something of the valuable work of Russell Carman and of many others, but all of this we must leave until there is opportunity to pursue the story beyond the early years that we have tried to cover.

A. C. Christie.

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SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this column solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. John T. Murphy, 421 Michigan Ave., Toledo, Ohio.
Twenty-ninth annual meeting, Kansas City, Mo., Sept. 25–28, 1928.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. Fred M. Hodges, 801 West Grace St., Richmond, Va.
Annual meeting, Minneapolis, Minn., June 11–15, 1928.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. Robert J. May, St. Luke's Hospital, Cleveland, Ohio.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. E. C. Samuel, New Orleans, La.

BUFFALO RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St.
Meets second Monday of each month except during the summer months, the place of meeting to be selected by the host.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. R. A. Arens, Michael Reese Hospital
Meets monthly on second Thursday from October to May (except during month of December) at Virginia Hotel. Dinner at 6 P.M., scientific session at 8 P.M.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. James H. West, 8314 Euclid Ave.
Meetings are held at 6 o'clock at the University Club, on the fourth Monday evening of each month from September to April, inclusive.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. O. J. Shore, 2033 Park Ave.
Meets monthly on second Friday from October to May, at Wayne County Medical Society Building.

CENTRAL ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. H. C. Kariher, Decatur, Illinois.
Regular meetings held quarterly.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. M. C. Sosman, Peter Bent Brigham Hospital, Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. E. Everett Rowell, 200 West 59th St.
Meets monthly on third Monday, New York Academy of Medicine.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. D. S. Childs, 316 Gurney Bldg., Syracuse, N. Y. Three meetings a year—April, August and November.

PACIFIC COAST ROENTGEN RAY SOCIETY
Secretary, Dr. Harold B. Thompson, Seattle, Wash.
Two meetings a year.

ROENTGEN RAY SOCIETY OF CENTRAL PENNSYLVANIA
Secretary, Dr. W. E. Reiley, Clearfield, Penna.
Two meetings a year, April and October.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. Eugene Pendergrass, University of Pennsylvania, Philadelphia.
Meets monthly on first Thursday evening, Pennsylvania Hospital.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.
Secretary, Dr. James M. Flynn, 282 Alexander St.
Meets monthly on the first Friday evening at 7.45 at the Rochester Medical Association Building.

ST. LOUIS ROENTGEN CLUB
Secretary-Treasurer, Dr. L. R. Sante, Metropolitan Building.
Meets first week of each month. Time and place of meetings designated by president.

TEXAS RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. C. P. Harris, Houston, Texas.
Annual meeting, Galveston, Texas, 1928.

VIRGINIA ROENTGEN RAY CLUB
Secretary, Dr. Wright Clarkson, 205 S. Sycamore St., Petersburg, Va.
Annual meeting Oct. 17, 1928.

British Empire

BRITISH RÖNTGEN SOCIETY
Meets on the first Tuesday of each month from November to June inclusive, at 8.15 P.M., at the British Institute of Radiology, 32 Welbeck St., London; W. 1.

BRITISH INSTITUTE OF RADIOLOGY
Secretary, Dr. John Muir, 32 Welbeck St., London, W. 1.
Meets at 32 Welbeck St., but regular dates and times of meeting have not yet been arranged.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets on the third Friday of each month during the winter at 8.30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

RADIOLOGICAL SECTION, AUSTRALASIAN MEDICAL CONGRESS
Secretary, Dr. C. A. Anderson, The Hospital, Dunedin.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

SECTION ON RADIOLOGY, CANADIAN MEDICAL ASSOCIATION
Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.
Next annual meeting, Charlottetown, P. E. I., June 21–23, 1928.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch.
Meets annually.

* Secretaries of societies not here listed are requested to send the necessary information to the editor.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA
Secretary, Dr. Walter Altschul, German University, Prague, II/52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GESELLSCHAFT FÜR RÖNTGENKUNDE UND STRAHLENFORSCHUNG)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.
Next meeting with the Gesellschaft deutscher Naturforscher und Aerzte will be in Hamburg, September, 1928.

SUD- UND WESTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.

NORD- UND OSTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.
Next meeting September 27, 1928, in Hamburg.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETA ITALIANA RADIOLOGIA MEDICA
Secretary, Professor M. Ponzio, University of Turin, Turin.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs S. A. Reinberg and S.G. Simonson.
Meets annually.
Fifth Annual Meeting in Kiev, Ukraine, May, 1928.

LENINGRAD ROENTGEN RAY SOCIETY
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly on the first Monday at 8 o'clock in the State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. A. Elektorowicz, 19 Hoza St., Warsaw.
Meets annually.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summertime.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with the exception of the Denmark Society, meets every second month except in the summertime:

SOCIETY OF MEDICAL RADIOLOGY OF SWEDEN
Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY
Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK
Secretary, Dr. H. Scheuermann, Copenhagen
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND
Meets in Helsingfors.

VIENNA SOCIETY OF ROENTGENOLOGY
Secretary, Professor Holzknecht, Vienna, IX, General Hospital.
Meets on the first Tuesday of each month from October to July.

VIENNA LETTER

(From our special correspondent)

WINTER DISEASES AMENABLE TO ROENTGEN THERAPY

At a recent meeting of the Vienna Seminary Evenings, Professor G. Holzknecht gave an address on the above subject. He discussed particularly such seasonal morbid conditions as the changes consecutive to freezing of the hands and feet and stated that the roentgen ray is an established remedy for these. The explanation of the action of the roentgen ray in these conditions is not quite clear. It is assumed that in skin thus changed there is a class of cells, possibly in the nerves of the blood vessels, which are in a hyperfunctioning condition. Roentgen rays really act in only one way, that is to lower the hyperbioses. Where there is no such hyperfunctioning condition, the rays fail to produce any therapeutic effect. It is admitted that the hyperbioses form a considerable part of many pathologic conditions. Two types of skin changes following freezing are recognized: in one, the skin is pink with red nodules due to infiltration; in the other, the skin is bluish red, soft, smooth and edematous but there are no infiltrations nor excoriations. The two forms are seldom combined. The first type appears to be due to a local change while the second is assumed to be due to a central (spinal or sympathetic) lesion. The roentgen rays are applied locally only in the first type. Two-tenths of an erythema dose is administered and repeated twice at three-day intervals. In the second form, which is assumed to be of central origin, the rays are applied to the lower cervical and upper dorsal region if the lesion is localized to the hands, and to the lower

dorsal and upper lumbar region if the feet are involved. Professor Holzknecht also dealt with other seasonal affections such as neuritides, sciatica and neuralgias. A considerable percentage of these cases are benefited by the roentgen ray. The irradiation is applied to the nerve roots and ganglia and minimal doses administered, one-tenth to one-twentieth of an erythema dose every three days for about two weeks. Cases which had been operated upon or treated with injections of alcohol proved refractory to roentgen-ray treatment. Professor Holzknecht spoke also of encouraging results achieved by radiation therapy in gastric and duodenal ulcers.

FINSEN TREATMENT OF EAR DISEASES

Dr. Hugo Lorenz has spent a couple of years in the Institute of Professor Finsen in Copenhagen studying the heliotherapy of oto-laryngological diseases and reported his experiences at the Budapest Royal Medical Society. He said that in the domain of heliotherapy Finsen's Institute still occupies the leading position in the world. The Institute is furnished with separate sections for special branches of the medical sciences. In the oto-laryngeal section, headed by Professor Strandberg, patients are given both local and general treatment. More stress is laid upon the general treatment, local applications being added only if there is a favorable biological reaction to the general applications. The general treatment may consist of a sun bath alone, if satisfactory insolation is secured, but in the majority of cases it is necessary to administer the Finsen bath in addition. The local treatment differs according to the affection. The largest contingent of patients are those with lupus and chiefly lupus of the mucous membranes of the nose, pharynx and ears. Treatment is begun with the whole light-bath applied for thirty to forty-five minutes every alternate day until the full dose of two and a half hours is reached. If a favorable reaction supervenes as manifested by a fall of temperature, increase of body weight, improvement of the local and eventually of the pulmonary symptoms, local treatment is then begun. This consists of irradiating with concentrated light the area of the lesion, if it is easily accessible, for thirty-four minutes, and after an interval of one-half hour, an additional seventeen minutes. On succeeding days neighboring areas are irradiated until the entire lesion has been exposed. If the lesion is not readily accessible, electrocoagulation is performed either alone or combined with surgery. The local application may be employed anywhere except in the larynx where edema may occur. Tuberculous otitis is usually subjected to combined treatment administering for the general treatment Finsen irradiation of unconcentrated light at a distance of 20 cm. for forty minutes. Results are very encouraging in all diseases treated. In lupus there are 60 per cent of recoveries and improvement in 94 per cent. In tuberculosis of the larynx there are 50 per cent recoveries and 75 per cent improvement. Other complications usually heal within a year, almost without exception. The only disadvantage of this method is its long duration, the average being one-half to one year, although the patients may follow their vocation during treatment if they happen to live in places where such treatment can be employed. This method of treatment has been experimented with also in other than tuberculous ear diseases, such as otosclerosis and chronic adhesions. In these cases the treatment proved advantageous, especially in suppressing the subjective noises.

UPPER LIMITS OF PLEURAL EFFUSIONS—EXPLANATION OF THE CONTRADICTORY FINDINGS BY PHYSICAL METHODS AND ROENTGEN RAYS

Dr. I. Schill, a Budapest roentgenologist, states that the upper limit of a pleural effusion when examined by physical methods appears to assume the form of the well-known Ellis-Damoiseau parabolic curve, the highest point of which is found near the scapular line. In contrast to this, the roentgen examination shows an oblique line running inwards and downwards over the lateral wall of the chest. He explains this divergence on the hypothesis that in the roentgen examination we see only the inner side of the parabola. He demonstrated this with the aid of conveniently placed small lead platelets.

A SIMPLE WAY OF LOCATING STONES IN THE KIDNEY

Dr. J. Hermann, assistant at the Urological Clinical of Budapest University, in a lecture held at the Medical Society, said that stones in the kidney appear magnified by about 15 to 20 per cent in the roentgenogram. To render location possible he makes a simple roentgenogram and with the same projection also a pyelogram. The two films, when dry, are placed one upon the other, in an exact manner that can be controlled by the shadow lines by superimposing the corresponding vertebrae at the level of the stone. The shadow of the stone, rendered transparent through the pyelogram, makes an exact location possible. For locating the stones, pneumopyelography is less suitable.

VISITS TO EUROPEAN CLINICS IN CONNECTION WITH INTERNATIONAL CONGRESS

The American Committee for the International Congress has found it impracticable to arrange for clinics in the various European centers at fixed times. The committee, however, wishes to inform all of those who will attend the Congress that all of the following European colleagues have extended invitations to Americans to visit them before or after the Congress: Prof. Dr. Artur Schüller, Wien; IX. Garnisongasse 7; Prof. Ferdinand Blumenthal, Berlin, Luisenstr. 9; Dr. Lars Edling, Lund, Sweden; Prof. Dr. Martin Haudek, Wien, VIII Langegasse 63; Dr. Hans Holfelder, Thorwaldsenplatz 6, Frankfurt a.M.-Sud; Dr. Edv. Collin, Finsens med. Lysinstitut, Copenhagen; Prof. Dr. R. Grashey, Munich; Prof. Dr. Fedor Haenisch, Klopstockstrasse 10, Hamburg.

There are undoubtedly many others who will be glad to receive a visit from American roentgenologists from whom formal invitations have not been received. The information received by the committee indicates that there will be a large attendance of Americans at the Congress, but that they are sailing in small groups at different times; some in May, some in June and some in July. The only feasible plan for visits to European clinics would seem to be that each individual or small group should correspond directly with those whom they wish to visit and arrange for definite dates. The letters from our European colleagues indicate that nearly all of them will be absent from their clinics after the middle of August. It is the opinion of the committee that visits to the clinics will be much more profitable if they are made before the Congress rather than afterwards.

SECOND INTERNATIONAL CONGRESS OF RADIOLOGY

EXHIBITION OF RADIOLOGICAL LITERATURE

As an important supplement to the transactions of the Congress relating especially to instruction in medical radiology, the committee of the Congress has decided to arrange a literary exhibition on the Congress premises in the House of Parliament. This exhibition will comprise all textbooks and handbooks on roentgen diagnosis, roentgen therapy, radium therapy, heliotherapy, medical electrology and radiophysics published during the last five years and also the latest complete volume of all radiological journals.

The Congress committee has much pleasure in inviting publishers to participate in this literary exhibition.

A. B. Nordiska Bokhandeln in Stockholm has kindly undertaken to arrange this exhibition and will also be at the service of those members of the Congress who might wish to order books or journals.

Gösta Forssell, President — Axel Renander, Secretary-General

PHILADELPHIA ROENTGEN RAY SOCIETY

The Philadelphia Roentgen Ray Society held its regular meeting January 5, 1928, in the Chapel Room of the Pennsylvania Hospital.

Dr. Pfahler presented a paper on "A Device to Prevent the Accidental Omission of a Filter." An abstract of this follows.

In all cases in which roentgen therapy is followed by some damage to the skin or subcutaneous tissues, the question of omission of

the filter arises. There are times when the omission of a filter is correct, but it must not be accidentally omitted or forgotten.

At a meeting of the American Roentgen Ray Society at Washington, D. C., in September, 1921, I advised the attachment of different colored ribbons to the various filters, which would hang down and indicate to the technician, while watching just what filter is in place, or if none were in place. This applied particularly to low voltage work. At a meeting of the Eastern Section of the American Roentgen Ray Society, at Atlantic City, January, 1923, I recommended the use of an electrical bell device to prevent the omission of a filter in deep roentgen therapy. We have been requiring also that two people examine the filter and the distance after each "set up." All of these recommendations are good.

Recently, Prof. G. Holzknecht has recommended a device that I think is better than my ribbon device. He recommends that the wire connecting the anode terminal terminate in a ring—or better, that the connecting high tension wire be broken, and the two ends terminate in rings. These two rings cannot be joined except by a double hook, to which is attached an indicator (which I have made of fiber $2\frac{1}{2}$" in diameter, on which I have painted the figures indicating the amount of filter—"0," "2," "4," "6" millimeters) tied by a string to each of the special filters or no filter. We have painted the no filter red. This can at all times be seen through the watcher's window. One must consciously consider this filter each time a connection is made. This seems to me to be the simplest and best device for low voltage work. For high voltage work, I would recommend that the filter be screwed in place, or connected electrically so that a bell will ring when it is not in place.

Dr. John T. Farrell presented a report on "The Roentgen Appearance of the Chest of the New-born Infant," basing his statistics upon the examination of 150 cases made within forty-eight hours after birth. He grouped the cases into four divisions depending upon the contour of the cardiac and great vessels shadows. The anthropometric findings showed the chests of the female to be less broad than those of the male, and other valuable information was presented from his research studies.

Dr. Temple Fay presented a paper on "Encephalography." He demonstrated the value of this procedure over that of ventriculography.

Dr. Anne E. Freese presented films and reported on a case of multiple chondromata.

Walter C. Barker.

INDIANA ROENTGEN SOCIETY

The Indiana Roentgen Society was organized in Indianapolis on January 28, 1928, with the following officers: President, Dr. R. C. Beeler, Indianapolis; President-Elect, Dr. H. J. Pierce, Terre Haute; Vice-President, Dr. L. F. Fisher, South Bend; Secretary-Treasurer, Dr. C. S. Oakman, Muncie.

COLLEGE FELLOWSHIP

The American College of Radiology has bestowed upon Professor Claude V. Regaud of Paris, and Professor Herman Wintz of Erlangen, Germany, honorary fellowship for their eminence and accomplishment in radiology.

INTERNATIONAL ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

MISCELLANEOUS

Caspari, Wilh., and Dessauer, Friedrich. Problems of the biological action of radiation (point heat hypothesis, necrohormone hypothesis). *Acta radiol.*, 1926, vi, 241–270.

The authors discuss the two well-known hypotheses to explain the biological action of radiations. One of these is physical, the hypothesis of "point heat;" the second is biological, the hypothesis of "necrohormones." It is believed that these hypotheses supplement one another, and together give a complete picture of the processes which are brought about in the organism by radiation. However, the two concepts are not mutually dependent on one another. The point heat hypothesis may hold good quite well even if the hypothesis of necrohormones does not survive the results of further research, and vice versa. Although each of these hypotheses was originally set up independent of the other, the fact that they supplement each other so completely is interesting and encouraging.

Christie, A. C. Roentgenology in North America. *Acta radiol.*, 1926, vi, 281–295.

A brief historical sketch is given of the development of roentgenology in North America. Brief accounts are given of the life and work of the most important of the pioneers in clinical roentgenology, namely, Francis H. Williams, Walter B. Cannon, M. K. Kassabian, Charles L. Leonard, E. W. Caldwell and Walter J. Dodd. Mention is also made of Americans who have contributed to clinical roentgenology and to the development of apparatus used by the roentgenologist. American contributions to development of apparatus are the interrupterless machine, the Coolidge tube and the Potter-Bucky diaphragm.

Dessauer, Friedrich. Remarks on the dosage problem. *Strahlentherapie*, 1926, xxiii, 579–593.

One frequently encounters the view that the production of a suitable physical unit and a satisfactory dosimeter would bring with them the complete solution of the problem of dosimetry. On the other hand, the view has been expressed that the physical measurement is immaterial. The author believes that these views can be harmonized. The biological signs or detectors, whether they be called erythema dose or by any other name, lose nothing in their intrinsic significance. It is necessary to have both—a measure of the action and a measure of the reaction.

The problem of dosage will be solved when we are able to predict the measure of reaction from administration of a known measure of action. The qualitative aspect of dosage must remain physical and should be retained, no matter whether one chooses to describe the quantitative aspect in terms either of the biological or the physical unit. The physical unit alone, however, will not suffice for it is necessary to have a picture or interpretation of the biological significance of a physical unit.

Deve, F. Does lipiodol have a local hydaticide action? *Compt. rend. Soc. de biol.*, 1926, xcv, 1093–1095.

The author concludes after animal experiments that lipiodol has practically no parasitical action on hydatid cysts. The experiments were carried out on rabbits, which were infected with hydatid cysts, treated with lipiodol and then roentgenograms made. It is shown that after lipiodol treatment the cysts retained their form, dimensions and resistance.

Dietlen, H., and Becker, V. Evacuation of the stomach contents under roentgenoscopic control. *Acta radiol.*, 1926, vi, 327–334.

The aspiration of gastric juice with a thin stomach probe under roentgenoscopic control represents probably the least painful method of evacuation. In many cases it not only saves the customary test breakfast but also gives better information as regards duration, quantity and acidity of the secretion of the gastric juice, and thus approaches the fractional evacuation of an alcoholic test drink. The procedure is especially suitable for the examination of ambulant patients.

Emile-Weil, M. P. Pernicious anemia caused by thorium. *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1926, I, 1627–1629.

Pernicious anemia is known to be often caused by overdose of the roentgen ray, and less often by radium. The present report is that of a case caused by thorium. The first such case was caused by lack of special precautions in the use of thorium-active solutions. In other

known cases the anemia was caused by too prolonged action of the radioactive substance. It is necessary in the use of this substance to use the most minute precautions. The effects of these anemias are often very serious and very difficult of treatment.

Failla, G. The question of a biological unit of radiation. *Acta radiol.*, 1926, vi, 413–431.

Radiation *per se* cannot be measured except through some effect which it produces on matter. Results of such measurements will depend upon the particular effect selected. A dose of radiation at a point within a tissue is completely defined by stating the intensity and the wave length of the radiation and the duration of the irradiation. Theoretically it makes no difference by what method the intensity is measured provided a given value can be duplicated at will, then it becomes always possible to determine the relation between the dose and resultant effect, which is the ultimate aim of dosage.

At present it is not definitely known what influence the wave length of the radiation has on the relation between the quantity factor of the dose and the effect produced. If the same intrinsic relation holds for all biological effects of radiation, the dosage problem becomes relatively simple. The question can be settled only by extensive experimentation. This work must be done no matter how radiation is measured and what unit is adopted. By expressing the problem in terms of the susceptibility ratio it becomes more tangible and certain ways of attacking it suggest themselves. There is some experimental evidence with radium radiations tending to show that the relation between quantity and effect for different qualities of radiation is not the same for all biological effects.

No simplification in dosage results from the use of a biological unit of radiation. For practical purposes a unit based on ionization seems to be most desirable at the present time. Even if a biological unit offered some advantages, in the last analysis it would have to be expressed in terms of some ionization unit for practical purposes. The definition of a suitable ionization unit is a simple matter. The duplication of the unit at any time or place presents certain technical difficulties which need further study.

de Gheldere, Ch. Influence of length of waves of radiations in relation with their effect on modifications on the alkali reserve of the blood in rabbits. *Compt. rend. Soc. de biol.*, 1926, xciv, 1263–1264.

It has been shown previously by the author that irradiation of the rabbit with ultraviolet rays will reduce the alkali reserve of the blood. From further work reported here, the following conclusions are drawn: (1) ordinary daylight has no effect on the alkali reserve; (2) ultraviolet rays after irradiation of two to three hours cause a reduction of alkali reserve; (3) when the animal is subjected to the roentgen ray for fifteen minutes using the Müller tube with 15 ma. a decrease in alkali reserve is noted comparable to that given with ultraviolet rays, and this produced very rapidly (reduced from 1.1 c.c. $NaHCO_3$ to 0.88 c.c. in 25 minutes); (4) the opposite effect was obtained with the Coolidge tube used for fifteen minutes, an increase being noted rather than a decrease in alkali reserve. Reduction of this factor in the blood is dependent on the wave length employed, short waves and long waves giving opposite results.

Glocker, R., and Kaupp, E. A thimble ionization chamber independent of the quality of the radiation; and the measurement of the scattered ray dose in the water phantom. *Strahlentherapie*, 1926, xxiii, 447–462.

A description is given of a new ionization chamber whose readings in r units are practically independent of the wave length from 50 kv. unfiltered radiation to 200 kv. filtered through 1 mm. Cu. This instrument after calibration for any radiation indicates the correct r readings of all radiations in the same region. The chamber is constructed of 97 per cent Acheson graphite plus 3 per cent silica laid over 0.6 mm. bakelite.

This chamber was compared with an aluminum ionization chamber in the measurement of recoil scattering and the depth quotient in a water phantom, and the results revealed the erroneous readings given by the aluminum chamber as a result of the Compton effect. The sources of error of the thimble ionization chambers were determined experimentally, demonstrating the need for standardization of the chambers if comparable dose measurements are to be attained.

Measurements of recoil scattering at the surface of the water phantom with the above described new chamber (the roentgen tube being thoroughly screened off on all sides) gave values distinctly lower than those hitherto reported. As a result of these measurements it is concluded that the erythema dose for large fields which has been stated to be 1200 r should be revised downward to about 800 r, if the erythema dose over small fields (1 × 1 cm.) is set at 500 to 600 r.

Groedel, Franz M., and Schneider, Erich. Experiments on the biological effects of roentgen rays. *Strahlentherapie*, 1926, xxiii, 411–446.

The addition of photosensitizing dyes such as eosin and rose bengal to suspensions of paramecia failed to render the protozoa sensitive to doses of one and four skin erythema units of roentgen rays. On the other hand, with a suitable change in the electrolyte content of the suspension, a biological effect of the roentgen rays could be demonstrated although doses up to twelve skin erythema units delivered to the culture medium itself failed to produce any effect on the organisms grown upon them. In other words, the roentgen-ray effect is tied up in some way with the electrolytes in the culture medium; and the effect is demonstrable only within a certain range of hydrogen ion concentration. Near the lower pH threshold consistent with life the roentgen-ray effect seems to be possibly stimulative but at the higher values it is distinctly depressing and toxic.

The authors found it possible to stimulate the multiplication rate of paramecia by adding 0.05 per cent potassium iodide to the culture medium. The application of one skin erythema unit to such a culture medium stimulated multiplication appreciably over that in the control. The addition of potassium iodide exerts a stimulating effect in itself, but potassium iodide plus roentgenization increases the stimulative effect and the effect appears to be entirely one of increased cell division, and there is apparently no visible change produced in the organisms.

Experiments on plant seeds showed the latter to possess a high degree of resistance to roentgen rays. Evidence of a stimulating effect by roentgen doses of 0.1 to 1.0 skin erythema unit was inconclusive. When seeds are placed in a medium in which they maintain a certain metabolic contact (for instance, swelling before sprouting), roentgen doses of one-third to one-tenth skin units cause a distinct depressing effect provided the medium contains electrolytes. Here again is emphasized the important rôle played by the surrounding medium. A direct effect on the cells may no doubt exist, but no definite experimental evidence of this has as yet been obtained.

White mice and guinea pigs fed a diet which had been irradiated with roentgen rays died. However, the deaths were not due to any "poison" generated in the food. The animals showed the typical symptoms of avitaminosis, and the results of the experiments would seem to indicate some deleterious action of the rays upon the vitamines.

Gudzent, F. Pharmacological and biological behavior of radioactive substances on internal administration. *Acta radiol.*, 1926, vi, 473–484.

The radioactive substances most utilized in medicine are radium, radon, mesothorium, radiothorium, thorium x, actinium, and uranium x. The unit of measurement for these substances is the weight, in the case of the solids, and the curie and its derivative, the eman, as the unit for gaseous emanations. The physical and chemical behavior of the radioactive substances in the organism conforms largely to those of the longer known related isotopic elements. The solid radioactive substances are mainly deposited in various parts of the body (bone, bone marrow and spleen), and to a smaller extent in the intestines and in the kidney. The gaseous elements have no fixed affinity and are eliminated mostly by the lungs.

The therapeutic doses for man are as follows: radium, 0.001 to 0.1 mg.; thorium x, 0.01 to 0.2 mg. The lethal dose is about 0.5 mg. for radium and 1.0 mg. for thorium x. The minimum therapeutic dose of radium emanation (thorium emanation is practically out of the question) lies somewhere between 20 to 40 eman. The tolerance dose varies greatly and its upper limit cannot be determined. The biological effects are numerous, being exerted particularly upon the blood and the hematopoietic organs, the capillaries, the chromaffin system, metabolism, the growth and the circulatory organs.

Curative effects of the radioactive substances have been found in gout, rheumatism, neuralgia and neuritis, chronic suppuration and inflammation, diseases of the blood and in many forms of essential hypertonia. The effect of these substances is entirely due to radiation, probably as a result of ionization and dissociation of susceptible substances. The radiation attacks the cell nucleus itself. There is no fundamental difference between large and small doses nor is there any essential difference in their effects. Numerous theories have been set up to explain the action but the nature of the physical and chemical changes produced in the cell nucleus are still unknown.

Gunsett, A. Quantimetric units in the practice of roentgen therapy. *J. de radiol. et d'électrol.*, July, 1927, xi, 353–381.

The absolute electrostatic unit has been very accurately defined by German physicists. But the question of the measurements made on the patient by this unit is by no means so definitely settled. And besides it is not necessary to use the absolute unit in practice.

Solomon's unit, though it is purely conventional, is the unit to be used in daily practice. Solomon's method is excellent and more easily applied with safety to the patient than any other. Standard conditions of gauging the ionometer should be adopted in all countries. The dosimeter of Dauvillier is a perfect instrument for making measurements in the water phantom and controlling the yield of the roentgen apparatus. But so far Dauvillier's unit of energy is not sufficiently developed to replace Solomon's unit, which remains the unit for practical use in roentgenology.

Hamrick, Robert A. The emptying of the gall bladder: An experimental study. *Am. J. M. Sc.*, August, 1927, clxxiv, 168–181.

The experiments reported were done upon dogs. The contrast material used in the roentgenographic study of the gall-bladder and its outlet was 40 per cent iodized oil, which was injected directly into the gall-bladder. Boyden's methods of feeding were used to produce the emptying of the gall-bladder during digestion. The following conclusions are drawn: The gall-bladder empties a portion of its contents into the duodenum with digestion. The contents pass to the duodenum through the cystic and common ducts. The emptying of the gall-bladder with digestion is intermittent. Periods of active emptying were usually short and could be definitely limited over a varying period. Emptying began within ten to forty-five minutes after feeding and was interspersed with varying intervals in which there was none.

The studies indicate that contractions of the musculature of the gall-bladder are the main factor in the normal emptying, while intrinsic periodic contractions appear to be important features brought into play with digestion. There is ample evidence that the gall-bladder does not tend to expel its contents during the fasting state. Respiratory movements as well as changes in the external and intra-abdominal pressure have only a minor part, if any, in the normal emptying. Mechanical factors such as passing a stomach tube, filling the stomach with air, aspiration of the stomach, and manipulation of the stomach tube in the stomach, caused a definite passage of some material from the gall-bladder in several instances, in contrast to the inability to cause expulsion of the material from the gall-bladder by ordinary changes in intra- and extra-abdominal pressure.

The sphincter at the lower end of the common duct is possibly one of the factors concerned in the regulation of the flow of bile from the gall-bladder although its action is not necessary for the emptying of the gall-bladder with digestion. External abdominal pressure caused some expulsion of the contents of the gall-bladder in one instance when the sphincter at the lower end of the common duct was eliminated, but feeding was necessary to cause marked emptying of the vesicle.

Heilbron, L. G. Teleroentgenography. *Acta radiol.*, 1926, vi, 531–533.

Teleroentgenography of the chest with a 2 meter focal plate distance and 0.1 second exposure is not possible with the best tubes operated economically. The author suggests that if economic considerations favor the rejection of this method a 100 cm. focal plate distance be substituted. The latter permits one to judge the state of the lungs perfectly, and the true size of the heart can be easily determined.

The ideal for teleroentgenography has not yet been attained. Further progress will probably lie in improvement in the films or in intensifying screens. For a 0.1 second exposure the 100 cm. focal plate distance is approximately the limit at which the best results can be obtained at present.

Herrmann, Heinrich. Improved method for protection against damage from high tension circuits using mechanical rectifiers. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926, xxxv, 93–94.

The oscillations produced by the spark preceding contact with the circuit act on a wireless receiver by means of which the high tension transformer is cut off. If no spark forms the device does not act. This might happen if both high tension currents were firmly touched before switching on the transformer. The safety device cannot be used in connection with oscillating apparatus, as for instance oscillating apparatus where needle rectifiers are used. However, by superposing high frequency oscillations of low power on the high tension current and by laying the antenna of the receiver beneath the floor, the safety device may be employed even in such cases. A person forming contact with the high tension current establishes a capacity between the antenna and the oscillation flowing along the high tension circuit and thus causes the safety mechanism to act. In the case of needle rectifiers a superposition of oscillations is not necessary because they are already present in the high tension circuit. In transformers and electron valve apparatus operated without rectifiers, a short spark gap (less than 1 mm.

in length) for the generation of oscillations is built into the current supply leading to the tube.

An apparatus of this type is superior to the well-known overload circuit breakers because it switches off the current upon contact with only one pole of the transformer and this is not dangerous in a transformer which is not grounded, whereas in the overload circuit breakers a complete circuit has to be established.

Hickey, P. M. The teaching of x-ray anatomy. *Acta radiol.*, 1926, vi, 577–582.

The subject may be divided into the teaching of roentgen-ray anatomy from the anatomical standpoint and from the roentgenological standpoint. Attention is directed to the desirability of arousing the student's interest in the study of anatomy by correlation with the subsequent clinical subjects. Roentgenology can be of considerable aid in the study of embryology. It is of considerable advantage to have roentgen-ray equipment for the use of students in every well-equipped anatomical laboratory. Roentgenology is of importance not only in the study of the calcium-containing structures of the body but also in the study of the circulatory system. While the student will get his basic ideas about the size and position of the various organs as revealed by dissection, yet he will have a better comprehension of regional anatomy if he can study also the outline of the various organs as revealed by the roentgenogram.

Holfelder, Hans. A new high tension ray-proof treatment tube for deep roentgen therapy. *Strahlentherapie*, 1926, xxiii, 532–540.

A description is given of a tube holder and stand embodying the following advantages: Complete protection from rays; complete protection from high voltage; absence of air contamination in the treatment room; ease of cleansing and disinfection, and great ease of manipulation. The device is so arranged that the treatment table can be easily moved in all horizontal directions and exactly placed, while at the same time fine adjustment and fixation can be attained in any desired position. The tube holder is fixed horizontally and so arranged as to be capable of rotation through 360°. It can also be lifted vertically to a desired height. Application of compression is facilitated to the utmost. In addition there is provided an automatic circuit which makes it impossible to mix filters or forget them. Ten illustrations are given exemplifying the different applications of the new device.

Holzknecht, G. Portable sphere gap. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926, xxxv, 95–96.

The author describes an instrument for the convenient measurement of tube voltage. The device is supported on the chest by means of the left hand, while the right hand gradually brings the spheres together by means of a lever. Attention is directed to the first appearance of the spark. Removal of the right hand causes the spheres to spring apart but the setting on the scale remains from which may be read directly the actual maximum kilovoltage on the tube.

Isaacs, Raphael, and Danielian, Arthur C. Maintenance of leukocyte level and changes during irradiation. *Am. J. M. Sc.*, July, 1927, clxxiv, 70–87.

A quantitative and qualitative study was made of the leucocytes appearing in the saliva and their relation to those of the blood in health and in certain diseases. The saliva as it appears at the opening of the ducts is practically free from leucocytes. The white cells are washed together from the mucous membranes through which they have wandered. The average leucocyte count in mixed saliva (in health) varies from 5 to 150 (rarely as high as 450) cells per cubic millimeter, the variations appearing during the course of the day, sometimes quite rapidly. The variations in the number of leucocytes in the saliva accompanies the changes in the leucocyte number of the blood but the relation is most commonly a reciprocal one. When a "digestive leucocytosis" fails to show in the blood it is sometimes evident in a great increase in the number of cells in the saliva. All types of white cells and probably blood platelets are found in the saliva, the number varying with the disease. Although the percentage of polymorphonuclear leucocytes bears much the same relation to the other cells in the normal saliva as in the blood, it may be relatively increased in chronic lymphatic leucemia, and similar diseases. When the cells are abundant in the saliva, the majority are living, but when they are scanty a greater proportion may show no signs of life. The process of "rigor mortis" of polymorphonuclear leucocytes is described. Some of its stages are suggestive of a reversal of the process of maturation of the myelocytes.

The number of leucocytes in the saliva is greatly increased in chronic myelogenous leucemia, often more so when the count is moderate than when it is extremely high. After roentgen-ray treatment there appears to be a great elimination of leucocytes, most

of them living, in the saliva. During the twenty-four hours after roentgen treatment of patients with malignant disease there may be a transient rise in the number of leucocytes in the peripheral circulation; and this may continue in some cases during the next seventy-two hours, but usually a subsequent decrease in numbers develops, and at times a definite leucopenia. During the course of the first twenty-four hours after roentgen treatment there may be a decrease in the number of leucocytes in the saliva with a temporary increase in the number of those in the blood. The increase in the number of leucocytes in the blood stream during the twenty-four hours after roentgen-ray irradiation is due in part at least to decreased elimination. The presence of myelocytes in the saliva suggests that these immature cells do not mature in the blood stream when they have reached it under pathologic conditions but are eliminated as such. With the decrease in the number of leucocytes in the blood there is a great increase in the number in the saliva during two to five days following roentgen-ray therapy. In some cases the cells were too numerous to count without dilution of the saliva, the material resembling pus in its appearance. In the myeloid form of leucemia roentgen-ray therapy may not influence markedly the number of white cells in the blood or in the saliva.

The cells may be greatly increased in number in the saliva in lymphoblastoma. In a leucemic lymphatic leucemia the number of leucocytes per cubic millimeter of saliva may be greater than that of the blood, the low white blood cell count being associated with the increased rate of elimination. In Hodgkin's disease the elimination of lymphocytes and eosinophiles in the saliva may be marked. When leucopenia is accompanied by increased elimination of leucocytes in the saliva, cell production is active and roentgen-ray treatment of lesions in the body is not contraindicated. It appears that leucocytosis may be due either to an increased production of leucocytes or a decreased elimination and leucopenia may be due to a decreased production or an increased elimination. The mucous membranes of the mouth and probably other parts of the gastro-intestinal tract act as points of elimination of leucocytes, in the general regulatory mechanism which tends to keep the blood elements within certain numerical limits.

Jansen, Hans, and Schultzer, Poul. Experimental investigations into internal radium emanation-therapy. I. Emanatorium experiments with rats. *Acta radiol.*, 1926, vi, 631–646.

Experiments were made with a radium emanatorium of 3.6 cubic meter capacity, and with a content of 2000 or 500 Mache units per liter of air respectively. Young rats which were kept continuously in the emanatorium containing 2000 Mache units per liter became distinctly ill after four weeks and died or were moribund in the course of the next week or two. With exposure for a shorter time (one to three weeks), a lesser or greater influence on the weight curve was observed some time after the rats were taken out of the emanatorium, the moribund condition also making its appearance in these cases at the beginning of the fifth week of the experiment, except in those which had been in the emanatorium for only one week, where a small effect on the weight was observed at the beginning of the fourth week. Apparently, therefore, there exists a latent period. Most of these rats recovered completely and later increased in weight in a normal manner.

Exposure in the emanatorium containing 500 Mache units per liter had no demonstrable effect.

Further examination of the moribund rats showed that the blood coagulated with abnormal velocity. The number of leucocytes decreased, especially the mononuclears. Hemorrhages occurred in the lungs, the spleen was gorged with blood, and there was some atrophy of the glands and testes. A consideration of the causes of the toxic effects observed suggests the following: (1) the action of the emanation absorbed by the organism, and (2) the action of the hard radiation produced by the radioactive decomposition products in the chamber.

Jaulin. Danger from the use of roentgen rays and radioactive substances and methods of avoiding them. *J. de radiol. et d'électrol.*, Apr., 1927, xi, 193–198.

The skin lesions resulting from long-continued use of roentgen rays are well known. The danger from them lies in the fact that they readily degenerate into cancer. It was chiefly the pioneers in roentgen-ray work who suffered from them, before the properties of the rays were generally understood. But in recent years 17 cases of death from acute aplastic anemia or leucemia have been reported in professional men from the use of roentgen rays or radioactive substances. Examination of the blood has shown either hypopolynucleosis and leucopenia or slight polynucleosis with eosinophilia. In many cases there was a decreased number of erythrocytes. The red cells showed slight anisocytosis and in a few cases showed poikilocytosis. In most of the cases there was a rela-

tive lymphocytosis. The resistance of the erythrocytes was not decreased.

In roentgenoscopy it is comparatively easy for the physician to protect himself from the primary rays but he is exposed to the secondary rays. For greater safety aprons of leaded rubber are worn. The roentgenologist should never put his hand in the field of the rays any more than a surgeon should touch a non-sterilized object. If palpation is necessary he should wear a protecting glove. Since deep roentgen therapy has come into use the danger from the rays has increased. Double partitions of lead are placed between the examiner and patient. It was found that the leaded windows placed in them for observation allowed the rays to pass around the edges so movable lead blinds have been added which can be opened from time to time; the patient has an electric bell so he can ring if necessary. For protection against radium, physicians are advised never to touch a radium preparation except with forceps and for the protection of deep organs to use a Felix table. In addition to that they should always work in well-aired rooms and take rather long vacations so as to allow the blood to recover. It is better to take several short vacations in the course of the year than a single long one.

Jensen, Fr.-G., and Norgaard, A. Clinical, roentgenologic and electrocardiographic investigations on healthy women in the course of normal pregnancy. *Compt. rend. Soc. de biol.*, 1926, xciv, 1213–1216.

The roentgenogram was used to demonstrate the increase in size of the heart due to the increased demands made by the growing fetus. These findings confirmed those obtained by the electrocardiographic tests and served to show exactly the nature and extent of increases in the size of the heart in these cases. Roentgenocardiograms are considered of much value in studying the effects of pregnancy on the heart.

Laborde, Simone. Treatment of cancer of the cervix. *J. de radiol. et d'électrol.*, May, 1927, xi, 274–281.

Tables are given showing the cancer statistics and percentages of cure of Döderlein, Beuttner, Heyman, Bailey and Healey, Regaud and Laborde and Wickham. The cancers are divided into four stages; the first stage covers operable cases with the cancer limited to the cervix, the second stage ones at the limit of operability, the third stage inoperable ones with the parametrium on one or both sides involved and the fourth stage ones in which the cancer has extended to neighboring organs. The number of cases cured decreases rapidly from the first stage to the fourth. Two periods are covered by the statistics of Bailey and Healey. Up to 1918 they used only vaginal radium treatment. After that they added an intracervical focus and external radium treatment, followed by roentgen-ray treatment. The statistics were much better in the second period than in the first. Statistics are also given from the Anticancer Center at Villejuif in the suburbs of Paris. Twenty-eight cases were treated in 1924; all of those in the first stage were cured, 55.5 per cent of those in the second stage, 26.9 per cent of those in the third stage and none of those in the fourth.

The author has the best results with relatively low doses, sometimes not more than 30–40 mc. The results are not nearly so good with doses of 60–70 mc., even with high filtration. A treatment of three to six days also seems to be better than a longer or shorter one.

Lorenz, Egon, and Rajewsky, Boris. The problem of the intensity distribution of roentgen rays in an irradiated medium. *Strahlentherapie*, 1926, xxiv, 175–191.

The authors present a reply to the criticism of Bornhauser and Holfelder. An analysis of all the experimental results confirms the findings of Lorenz and Rajewsky regarding the limits of applicability of the ionization and photographic methods. The claim of Holfelder that the mantle of scattered radiation is of negligible character is regarded as incorrect. The mantle of scattered radiation is dependent on conditions of scattering and should be considered in radiation practice. The authors' claims regarding the limits of applicability of the small chamber and photographic method of intensity distribution have been confirmed by independent observers.

Martius, Heinrich. Ovarian irradiation and offspring. *Strahlentherapie*, 1926, xxiv, 101–124.

In the present discussion the author excludes from consideration the question of injury to the fetus by roentgen rays, that is, injury to the offspring after irradiation of the pregnant mother. The risk of injury to the offspring appears *a priori* to be greater in cases where the ovum is fertilized shortly after irradiation than in cases where fertilization occurs some time after irradiation. Experiment and clinical observation seem to agree that early fertilization or later fertilization after irradiation of the ovum will result in an early intrauterine death of the embryo, and abortion. This has

been proven to occur in animals and seems probable in man. Another effect which has been definitely demonstrated in animal experimentation is decrease in size of the litter. There also seems to be agreement that irradiation of the ovum followed by fertilization may result in an injured embryo both in animals and in man. A third effect demonstrated in animal experiment and probably occurring also in man is injury to the somatic portion of the germ cell. A final possibility is inheritable injury to the germ cell. The latter appears to have been demonstrated in white mice by the experiments of Little and Bagg, and others.

Mendeléefe, P. The action of irradiations on the guinea pig. *Compt. rend. Soc. de biol.*, 1926, xciv, 1274–1277.

The effect of irradiations on guinea pigs was studied from two points of view: (1) the physical effect on electrical resistance of the liver of irradiated and normal animals, and (2) the biological effect of the irradiation *in vitro* of embryonic tissue cultures in the plasma of normal and irradiated animals. The ventral side of the animals was exposed to the roentgen ray in a dose of 720 R, corresponding to a current of 4 ma., 180,000 volts, with a filter of 0.5 mm. of copper and 1 mm. of aluminum at a distance of 23 cm. for ten minutes. The electric resistance of the membranes of irradiated animals fell from the normal figure of 1,790 ohms to 925 and 979 ohms. After four to five days this resistance increased without returning to its normal value, but to between 20 to 38 per cent less than normal. The decrease in electric resistance of the cellular and intercellular spaces has a direct relation to the increased permeability of the cells which facilitate the ionic interchanges between the cells and the surrounding fluids.

For tissue cultures the skin and intestines of embryonic guinea pigs were used, these being suspended in fresh irradiated plasma. These show a slight growth in the plasma of irradiated guinea pigs and the fragments of intestines retained their peristaltic movements for two to three weeks. The embryonic skin gave a good growth in the irradiated plasma and gave rise to a large number of fibroblasts as well as epithelial cells. Slide preparations showed these cells to be in a high state of mitosis; from 30 to 40 per cent of the cells were observed in various stages of mitotic division.

These experiments showed that irradiation produced changes in the physicochemical conditions of the tissues of the animals irradiated and caused at the same time decomposition of the fluids which liberated some substance which acted on the cellular chromatin so as to activate cell division *in vitro*. It may be assumed that the same effect would be produced *in vivo*. It is by their direct influence that roentgen rays modify the physicochemical condition of the cells and the blood plasma; the cell growth *in vitro* is due to these modifications, and are secondary effects of the roentgen ray. These effects can be produced with doses from 500 to 900 R.

Nadson, G., and Rochlin-gleichgewicht, E. The effect of the roentgen ray on the protoplasm and nucleus of living vegetable cells. *Compt. rend. Soc. de biol.*, 1926, xciv, 249–251.

The primary action of the roentgen ray on cells consists of ionization of the protoplasmic colloids, producing a splitting up of the protein-lipoid combination. At the same time there is a dehydration of the protein colloids, which then takes on a finely granular structure. The present work was done on the epidermis of the skin of the onion under the following conditions: bulb in gas, ionic-electronic, tension 150 kv., 2 ma., without filter, 23 cm. from cathode, irradiation lasting from 40 to 50 minutes. In the first thirty minutes of irradiation only the protoplasm outside the nucleus was affected, the nucleus itself remaining normal. After an hour of irradiation the nucleus in some cases shows fine granulation analogous to the cytoplasm, but not in many instances. In about three hours the change in the nucleus is more pronounced, forming many small vacuoles; the form and structure of the nucleus suffers definite change. The structure becomes alveolar and more and more of the appearance of vacuoles, with small droplets of fat. The changes then are the same for the nucleus as in the cytoplasm, but, as stated before, this takes place in the nucleus more slowly than in the cytoplasm.

Nadson, G.-A., and Rochlin-gleichgewicht, E.-I. The chondriosome is the part of the cell most sensitive to the roentgen ray. *Compt. rend. Soc. de biol.*, 1926, xcv, 378–380.

The authors have shown previously that the cytoplasm is more sensitive to the roentgen ray than is the nucleus, and in the present study they show that the chondriosome is the part of the cell which is most sensitive to the roentgen ray. As in the previous work, the epidermis of the onion skin was used in the present experiments. It is further proved that the roentgen ray accelerates the vital processes, bringing about aging of the cell more rapidly and causing death earlier for this reason.

Nakashima, Yoshisada. Some experiments on the fundamental process in the biological action of roentgen rays. *Strahlentherapie*, 1926, xxiv, 1–36.

Studies on irradiated colloidal solutions showed that irradiation produced an increase in the number of particles in suspension which, when observed from time to time, exhibited wave-like fluctuations in numbers. Clouding of the solutions produced by irradiation became gradually stronger with time, and the degree of clouding was found to be a function of the absorbed roentgen-ray energy. The latter shows that the clouding does not run parallel with the curve of the number of particles which seems logical, for only those particles showing Brownian movement were taken into consideration in the experiments.

The results seem to show clearly that after absorption of roentgen-ray energy in a globulin solution, observed in a dark field, there first arise very small particles in active Brownian movement. These particles are at first very small, gradually increase in size, and at the same time there occurs a decrease and finally cessation of the Brownian movement. The particles then settle out. From the time of irradiation and the first appearance of these particles there is an interval which, under the experimental conditions, was found to be dependent on the absorbed radiation energy; that is, first there is a latent period, then an increase to a first maximum of visible particles, then a distinct decrease, followed later by another sharp increase to a second maximum. With increased absorption of the dose of radiation, the course of the reaction is shortened and the amplitudes are increased. The fundamental character of the phenomenon (occurrence of particles with Brownian movement and the appearance of clouding) was independent of the absorbed radiation energy. It was found to occur even with the smallest doses administered and the process seemed to be fundamentally the same with both the hard and soft rays. Control experiments in which the colloidal solutions were gradually warmed showed the same characteristic features noted above and the same dependence of the curve upon the heat energy applied.

Some experiments on the salivary gland of *Limnea stag.*, which received an energetic irradiation corresponding to 100 skin erythema units, resulted in a somewhat more active Brownian movement of the particles in the cell nucleus. There also seemed to be an increase in the number of granules containing actively moving particles. Irradiation of amebae resulted in considerable individual differences. The most striking change consisted in a distinct increase in size of the cell after sufficient exposure and that there appeared within the cell numerous small particles with typical Brownian movement. The rate of division of such amebae was distinctly retarded during the first few days following irradiation, and after five days the rate returned to normal.

These experiments are regarded as supporting the heat-point theory of the action of roentgen rays proposed by Dessauer, and nothing was noted in these experiments suggesting contradiction to Dessauer's theory.

Neeff, Th. The ray protector and improvement of its action. *Strahlentherapie*, 1926, xxiv, 161–174.

Protecting devices for physicians and attendants in most roentgen institutes unfortunately do not offer the degree of safety which seems to be demanded in view of the permanent effects possible from small doses. The author demonstrates by means of photographic films the degree of hazard to which attendants are exposed by continued exposure during occupation in a relatively modern roentgen establishment. It was found that the so-called tolerance dose was considerably overstepped in many instances. The author discusses the various sources of error in the method of determining the quantity of stray radiation so as to facilitate its application in testing the efficacy of protective devices in general. Tests made on devices produced by German manufacturers show that in their present form of construction, a considerable degree of protection is attained.

Nölke, Wilhelm. A new milliammeter illuminator. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926, xxxv, 282.

A description is given of a device consisting essentially of a transformer and light projector. The whole apparatus is grounded to eliminate the effect of magnetic field. The light source is a gas-filled 10 watt bulb. A series of lenses permits projection of a narrow beam adjustable for 1 to 10 meters distance. Interposition of screens and filters can cut down disturbing light effects to the minimum.

Notice for 1926 of the German Roentgen Society on the use of protective measures against roentgen rays. *Strahlentherapie*, 1926, xxiii, 193–194.

1. Attention is directed to the dangerous properties of roentgen rays, the need for instruction of those exposed to the rays, and the recommendation that the notice be posted where attendants shall read it.

2. Working with rays up to 100 kv. the tube should be surrounded with protecting material of at least 2 mm. lead equivalent. Satisfactory protection is obtained in most cases by this thickness of lead. When operating at more than 100 kv. protection against the direct rays is insufficient, and provision should be made for protection from secondary radiations. Recommendations are also made regarding insulation of the therapy room against penetration of rays through the walls, floors and ceiling. A 4 mm. lead equivalent is necessary for protection. Lead windows should be at least equal in absorption properties to the minimum requirement.

3. Owing to possible poisoning from lead sheeting, this material should be painted or covered over with a layer of wood. Leaded rubber and lead glass do not require any coating.

4. Although adequate protection may be provided in the therapy room, it is recommended that attendants keep out of the room as much as possible; and when in the room to occupy a position, when possible, in the shadow of the anticathode.

5. Roentgenoscopes and instruments used for measuring radiations should also be adequately protected; but since these are used only occasionally the lead glass protection need be only 5 to 10 mm. thick for the sake of convenience in handling.

6. Those in responsible charge should if possible make their own tests of leaks either roentgenoscopically or roentgenographically.

7. The director of a roentgen laboratory should have periodic tests made of the efficacy of the protection devices by competent experts.

8. None of the attendants should repeatedly act as a test object for determining the efficiency of the roentgen apparatus or tube.

9. Every attendant, practitioner, or nurse, has the right to refuse to work in a roentgen laboratory not provided with sufficient protection. Such a refusal should not be ground for dismissal. This applies also to the personnel of factories and establishments which construct or sell roentgen apparatus or tubes.

Nürnberger, Ludwig. Ovarian irradiation and offspring. *Strahlentherapie*, 1926, xxiv, 125–148.

In considering the problem of germ cell injury by roentgen rays, a sharp distinction should be made between (1) fertilization of irradiated ova before occurrence of roentgen sterility (that is fertilization during the stage of injury), and (2) fertilization of irradiated ova after cessation of the roentgen sterility (that is, fertilization during the stage of restitution). (1) If an ovum is fertilized before the onset of roentgen sterility, an injured embryo *may* arise from it. Entirely acceptable observations on *viable* offspring with injuries from this cause have not yet been found in the case of man and the higher mammals; on the other hand, there have been repeatedly observed, both in animals and in man, the occurrence of phenotypically complete and normal offspring from ova irradiated shortly before fertilization. (2) In fertilization after cessation of roentgen sterility a phenotypical injury of the offspring seems to be highly improbable.

In addition, no satisfactory evidence has yet been brought forth in favor of genetic injury of the ovum. The variable animal experiments and clinical observations, would indicate that the only probable effect would be some recessive hereditary injury which does not occur in all irradiated ova and which is dependent on more than one hereditary factor. As a consequence, a genetic injury of the ovum would be so unusually rare as to be of little practical significance.